

TECHNOLOGY OF CELLULOSE ESTERS

A THEORETICAL AND PRACTICAL TREATISE ON THE ORIGIN,
HISTORY, CHEMISTRY, MANUFACTURE, TECHNICAL APPLICATION
AND ANALYSIS OF THE PRODUCTS OF ACYLATION AND
ALKYLATION OF NORMAL AND MODIFIED CELLULOSE, INCLUDING
NITROCELLULOSE, CELLULOID, PYROXYLIN, COLLODION,
CELLOIDIN, GUN COTTON, ACETYLCELLULOSE AND VISCOSE,
AS APPLIED TO TECHNOLOGY, PHARMACY, MICROSCOPY,
MEDICINE, PHOTOGRAPHY, AND THE VARIOUS
AND PEACEFUL ARTS

IN TEN VOLUMES

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ABBREVIATIONS.

A. A. A. S.	American Association for the Advancement of Science	h. p.	horse power
Anon.	Anonyme (Anonymous)	hr.	hour(s)
A. O. A. C.	Association of Official Agricultural Chem- ists	insol.	insoluble
abs.	absolute	in.	inch
A. C.	Alternating current	k.	kilogram
Act.	Action	kw.	kilowatt
Add.	Addition Patent	l.	liter(s)
alc.	alcohol ethyl	l.	lavo
alk.	alkaline	lab.	laboratory
amp.	ampere	lb.	Avoirdupois pound(s)
amt.	amount	Ltd.	Limited
approx.	approximate	m.	meter
at.	atom, atomic	m	meta
atm.	atmosphere(s)	mfr.	manufacturer
atm. pr.	atmospheric pressure	mfg.	manufacturing
as-	asymmetric	mgm.	milligram
av.	average	min.	minute(s)
b.	boil(s), boiling	mm.	millimeter
b. pt.	boiling point	mol.	molecule(s)
c.	asymmetric carbon atom	mol. wt.	molecular weight
cal.	calorie	m. pt.	melting point
cc.	cubic centimeter(s)	M. S.	Mild steel
chem.	chemical	nor.	normal
C. I.	cast iron	n. t. p.	normal temperature and pressure (0° C, 760 mm.)
com.	commercial	o-	ortho
comp.	composition	ord.	ordinary
compd.	compound	oz	Avoirdupois ounce
conc.	concentrat-ed, ion	p-	para
cor.	corrected	pp.	precipitate
C. O. V.	Concentrated oil of vit- riol	p.	pint
c. p.	candle power	qt.	quart
crys.	crystals, crystallized	quant.	quantitative
cu.	cubic	recryst.	recrystallized
cu. ft.	cubic foot (feet)	r. p. m.	revolution per minute
cu. m.	cubic meter(s)	sat.	saturate(d)
cwt.	hundred weight	sc.	scruple
D. C.	Direct current	sec.	second(s)
d-	dextro	soln.	solution
d.	density	Soc.	Societe
diam.	diameter	sp. gr.	specific gravity
dcm.	decimeter	sq.	square
dil.	dilute	S. T. P.	Standard temperature (15.56° C.) and pres- sure (760 mm.)
dr.	dram	sym.	symmetrical
fl.	fluid	temp.	temperature(s)
Farb.	Farbenfabriken	v-	vicinal
f. pt.	freezing point	vac.	vacuum
gal.	U. S. gallon, 3785 cc.	vol.	volume(s)
Ges.	Gesellschaft	wt.	weight
gm.	gram(s)	°	degrees Centigrade (al- ways)
gr.	grain(s)	%	per cent. by weight

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IV	82	11	0	40	111	238	508	466
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LIST OF ABBREVIATIONS TO LITERATURE

Prepared by DR. CARL MARX

A. and N. J.	Army and Naval Journal
Aarau, Archiv der Med.	Archiv. der Medizin, Chirurgie, und Pharmazie
Aarau, Mitth.	Mittheilungen des Aargauischen Naturforschenden Gesellschaft
Abbeville, Bull. Soc. Linn.	Compte Rendu et Bulletin de la Société Linneenne du Nord de la France
Abbeville, Mem. Soc. Emul.	Memoires de la Société d'Emulation d'Abbeville
Abeille, J.	L'Abeille, Journal d'Entomologie
Abeille mem.	L'Abeille: memoires d'Entomologie
Abeille Soc.	(Publications de la Soc. Entomologie de France) La Abeille. Journal de Entomologie
Acad.	Memoires de l'Academie des Sciences
Acad. Caes. Leop. Nova Acta	Nova Acta physico-medica Academiae Caes. Leopoldino-Carolinae Naturae Curiosorum
Acad. Natur. Curios. Nova Acta	Nova Acta Academiae Caesareae Leopoldino-Carolinae Germanicae Naturae Curiosorum
Acireale Accad. Atti	Atti e Rendiconti dell' Accademia di Scienze, Lettere e Arti dei Zelanti e PP. dello Studio di Acireale
Acireale, Soc. Ital. Micro. Boll.	Bollettino della Societa Italiana dei Microscopisti
Acquoy, Tijdschrift	Tijdschrift voor Wis-, Natuur-, en Wertuigkunde
Acta Math.	Acta Mathematica
Actes Soc. Helvetique	Actes de la Société Helvétique des Sciences Naturelles
Adansonia	Adansonia: Recueil d'observations botaniques
Adelaide Phil. Soc. Trans.	Transactions and Proceedings and Report of the Philosophical Society of Adelaide, South Australia
Aeronaut. J.	The Aeronautical Journal
Aeronaut. Soc. Reports	Annual Reports of the Aeronautical Society of Great Britain
Aeronaute	L'Aeronaute: bulletin mensuel international de la Navigation Aérienne
Afhandl. Fysik.	Afhandlingar i Fysik, Kemi, och Mineralogi
African Assoc. Proc.	Proceedings of the African Association for promoting the Discovery of the Interior Parts of Africa
Agen, Soc. Agric. Recueil	Recueil des Travaux de la Société d'Agriculture, Sciences, et Arts d'Agen
Agram., Program Gymnas.	Program des k. k. Akademischen Gymnasiums zu Agram
Agric. Gaz.	The Agricultural Gazette
Agric. Gaz. N. S. Wales	Agricultural Gazette of New South Wales, The
Agric. J. India	Agricultural Journal of India
Agric. Ledg.	Agricultural Ledger
Agric. Soc. J.	The Journal of the Royal Agricultural Society of England
Agric. Stud. Gaz.	Agricultural Students' Gazette. A Quarterly Journal edited by Students at the College, Cirencester
Agron. Ztg.	Agronomische Zeitung
Aix, Acad. Mem.	Recueil de Memoires de la Société des Amis des Sciences, des Lettres, de l'Agricultur, et des Arts a Aix

- Albany Inst. Proc. Proceedings of the Albany Institute
 Albany Inst. Trans. Transactions of the Albany Institute
 Alger. Bull. Soc. Climat. Bulletin de la Société de Climatologie Algérienne
 Alk. Alkohol
 Allelod. Soc. Trans. The transaction of the Allelodidactic Society
 Allg. Berg. Ztg. Allgemeine berg- und hüttenmännische Zeitung
 Allg. Bot. Zts. Allgemeine Botanische Zeitschrift für Systematik, Floristik, Pflanzengeographie, etc.
 Allg. Deut. Naturhist. Ztg. Allgemeine Deutsche naturhistorische Zeitung
 Allg. Deut. Ornith. Ges. See J. Ornith
 Allg. Fischerei Ztg. Allgemeine Fischerei Zeitung
 Allg. Forst-Jagd-Zts. Allgemeine Forst- und Jagd-Zeitung
 Allg. Gerber-Ztg. Allgemeine Gerber-Zeitung
 Allg. Schweiz. Ges. Gesam. Naturwiss. See Zurich, Schweiz. Ges. N. Denkschr.
 Allg. Syn. Suikerfab. Algemeen Syndicat van Suikerfabrikanten in Nederl.
 Ind. With Arch-Suikerind, etc.
 Allg. Zts. Bierbr. Malzfabr. Allgemeine Zeitschrift für Bierbrauerei und Malzfabrikation
 Allier. Bull. Soc. Emul. Bulletin de la Société d'Émulation du département de l'Allier: Sciences, Arts, et Belles-Lettres
 Alpina Alpina, eine Schrift der genauen Kenntniss der Alpen gewidmet; von Carl Ulisses von Salis und J. R. Steinmueller
 Altenburg Mith. Mittheilungen aus dem Osterlande; herausgegeben von der Naturforschenden Gesellschaft zu Altenburg
 Amat. Mechan. Soc. J. The (Quarterly) Journal of the Amateur Mechanical Society
 Amer. Acad. Mem. Memoirs of the American Academy of Arts and Sciences
 Amer. Acad. Prog. Proceedings of the American Academy of Arts and Sciences
 Amer. Agric. American Agriculturist
 Amer. Ann. Phot. American Annual of Photography
 Amer. Apoth. Ztg. Deutsch-Amerikanische Apotheker Zeitung
 Amer. Artisan American Artisan
 Amer. Assoc. Proc. Proceedings of the American Association for the Advancement of Science
 Amer. Brewers Rev. American Brewers Review
 Amer. Builder The American Builder
 Amer. Chem. J. American Chemical Journal
 Amer. Chemist American Chemist
 Amer. Drug. American Druggist and Pharmaceutical Record
 Amer. Electrochem. Soc. American Electrochemical Society
 Amer. Engin. & Railroad J. American Engineer (Car Builder), and Railroad Journal
 Amer. Ethnol. Soc. Trans. Transactions of the American Ethnological Society
 Amer. Entom. Soc. Trans. Transactions of the American Entomological Society and Proceedings of the Entomological Section of the Academy of Natural Sciences
 Amer. Fertilizer American Fertilizer, The
 Amer. Food J. American Food Journal
 Amer. Gas Light J. American Gas Light Journal, The
 Amer. Geogr. Soc. Bull. Bulletin of the American Geographical and Statistical Society
 Amer. Geogr. Soc. J. Journal American Geographical Society, New York
 Amer. Geogr. Soc. Proc. Proceedings of the American Geographical and Statistical Society of New York

Amer. Geol. and Nat. As- soc. Reports	Reports of the Meetings of the Association of Ameri- can Geologists and Naturalists at Philadelphia
Amer. J. Conchol.	American Journal of Conchology
Amer. J. Dent. Sci.	American Journal of Dental Science
Am. J. Math.	American Journal of Mathematics
Amer. J. Med. Sci.	American Journal of the Medical Sciences
Amer. J. Otol.	The American Journal of Otology
Amer. J. Pharm.	American Journal of Pharmacy
Amer. J. Physiol.	The American Journal of Physiology
Amer. J. Physiol., Boston	American Journal of Physiology, Boston
Amer. J. Psychol.	The American Journal of Psychology
Amer. J. Pub. Health	American Journal of Public Health
Amer. J. Sci.	The American Journal of Science
Amer. Mach.	American Machinist
Amer. Math. Soc.	See N. Y. Amer. Math. Soc.
Amer. Med.	American Medicine
Amer. Med. Assoc. Trans.	Transactions of the American Medical Association
Amer. Med. Phil. Reg.	The American Medical and Philosophical Register; or Annals of Medicine, Natural History, Agriculture, and the Arts
Amer. Med. Recorder	American Medical Recorder
Amer. Meteorol. J.	American Meteorological Journal
Amer. Micro. J.	The American Quarterly Microscopical Journal. With which is also published the Transaction of the New York Microscopical Society
Amer. Micro Soc. Proc	Proceedings of the American Microscopical Society
Amer. Micro. Soc. Trans.	Transactions of the American Microscopical Society
Amer. Mineral. J.	The American Mineralogical Journal
Amer. Min. Gaz.	The American Mining Gazette and Geological Maga- zine
Amer. Monthly Micro J.	American Monthly Microscopical Journal
Amer. Mus. Bull.	Bulletin of the American Museum of Natural History
Amer. Mus. Mem.	Memoirs of the American Museum of Natural History
Amer. Natur.	American Naturalist
Amer. Ophthalm. Soc. Trans.	Transactions of the American Ophthalmological So- ciety
American Perfumer	American Perfumer and Essential Oil Review, The
Amer. Phil. Soc. Proc.	Proceedings of the American Philosophical Society held at Philadelphia
Amer. Phil. Soc. Trans.	Transactions of the American Philosophical Society, held at Philadelphia, for promoting useful knowledge
Amer. Phot.	American Photography
Amer. Poly. J.	The American Polytechnic Journal
Amer. Quart. J. Agric.	American Quarterly Journal of Agriculture and Science
Amer. Reports State Entom.	See Ill., Mass., Mo., N. Y.
Amer. Soc. Agr. Sci. Proc.	Proceedings of the Society for the Promotion of Agri- cultural Science
Amer. Soc. Civ. Engin. Trans.	Transactions of the American Society of Civil Engineers
Amer. Soc. Micro Proc.	Proceedings of the American Society of Microscopists
Amer. Sugar. Ind.	American Sugar Industry and Beet Sugar Gazette, The
Amer. Vet. Rev., N. Y.	American Veterinary Review, N. Y.
Amherst. Agric. Sta. Re- port	Annual Report of the State Agricultural Experiment Stations, at Amherst, Mass.
Amici, Giorn. Loscano	Giornale Loscano di Scienze mediche, fisiche e naturali
Amiens Acad. Sci. Mem.	Memoirs de l'Académie des Sciences, des Lettres et des Arts d'Amiens

- Ammon, *Monatschr. Med.* Monatschrift für Médecin, Augenheilkunde, und Chirurgie
- Ammon, *Zts. Ophthalm.* Zeitschrift für die Ophthalmologie
Amsterdam Werken van het Genootschap ter Bevordering der Natuur-, Geneesen Heelkunde. See Maandbl. Nat.
- Amsterdam, Akad. Jaarb. Jaarboek van de koninklijke Akademie van Wetenschappen gevestigd te Amsterdam
- Amsterdam, Akad. Proc. Koninklijke Akademie van Wetenschappen te Amsterdam. Proceedings of the Section of Sciences
- Amsterdam, Akad. Verh. Verhandelingen der koninklijke Akademie van Wetenschappen.
- Amsterdam, Akad. Versl. Verslagen en Mededeelingen der Koninklijke Akademie
Mededeel. van Wetenschappen. Afdeling Naturkunde
- Amsterdam, Akad. Wet. Processen-Verbaal van de gewone Vergaderingen der
Proc. Koninklijke Akademie van Wetenschappen. Afdeling Naturkunde.
- Amsterdam, Archief Wisk. Archief uitgegeven door het Wiskundig Genootschap
Genoots.
- Amsterdam Bijdr. Dierk. Bijdragen tot de Dierkunde uitgegeven door the
(Koninklijk Zoologisch) Genootschap Natura Artis
Magistra, te Amsterdam
- Amsterdam, Bull. Congr. Bulletin du Congres International de Botanique et
Bot. d'Horticulture reuni a Amsterdam
- Amsterdam Congr. Bot. Actes du Congres International de Botanistes, d'Horticulteurs. ... tenu a Amsterdam, en 1877
- Amsterdam • Genootsch. "Natura Artis Magistra"
Genootsch. See Amsterdam Bijdr. Dierk
- Amsterdam Nat.-, Genees- en Heel- See Maandbl. Nat
kunde
- Amsterdam, Het Inst. Het Instituut
Amsterdam, Mengelwerk Mengelwerk von uitgelezen en andere Wisen Natuurkundige Verhandelingen
- Amsterdam, Nieuw. Verh. Nieuwe Verhandelingen der eerste Klasse van het Koninklijk Nederlandsche Instituut van Wetenschappen, en Schoone Kunsten te Amsterdam
- Amsterdam, Nieuw. Wis. Verzameling van nieuwe wiskundige Voorstellen door
Voorstel. de Leden van het Wiskundig Genootschap, onder de zinspreuk: *Een onvermoeide arbeid komt alles te boven*, elkander tot onderlinge oefening opgegeven
- Amsterdam Nederl. Aardr. Tijdschrift van het (Kon.) Nederlandsch. Aardrijkskundig Genootschap, gevestigd te Amsterdam
- Amsterdam, Onderz. Phys. Onderzoekingen gedaan in het Physiologisch Laboratorium van de Doorluchtige en Klinische Scholen te Amsterdam
- Amsterdam, Tijdschr. Tijdschrift voor Natuurkundige Wetenschappen en
Natuurk. Wetens. Kunsten
- Amsterdam, Tijdschr. Wis. Tijdschrift voor de Wis- en Natuurkundige Wetenschappen, Letterkunde, en Schoone Kunsten te Amsterdam
- Amsterdam, Verh. Verhandelingen der Eerste Klasse van het Koninklijk Nederlandsche Instituut van Wetenschappen, Letterkunde, en Schoone Kunsten te Amsterdam
- Amsterdam, Verh. • Ge- Verhandelingen van het Genootschap ter Bevordering
noots. Geneesk. der Geneesen Heilkunde, en Schoone Kunsten te Amsterdam
- Amsterdam, Verzam. Ber. Verzameling van Berichten over eenige onderwerpen
Navig. des Navigatie

Amsterdam Zool. Genootsch. "Natura Artis Magistra"	See Nederl. Tijdschr. Dierk.
Anales agrol.	Anales Agronomicos
Anales fis. quim.	Anales de la sociedad espanola de fisica y quimica
Anales inst. med. nacional	Anales del instituto medico nacional
Anales Minería Mex.	Anales de la Minería Mexicana, Revista de Minas
Analyst	The Analyst, including the Proceedings of the Society of Public Analysts
Anat.	Anatomie
Anat. Anz.	Anatomischer Anzeiger. Centralblatt für die Gesamte Wissenschaftliche Anatomie. (Amtliches Organ der Anatomischen Gesellschaft)
Anat. Ges.	See Anat. Anz.
Anat. Hefte	Anatomische Hefte. Referate und Beiträge (Beiträge und Referate) zur Anatomie und Entwicklungsgeschichte.
Anat. Soc. Proc.	See J. Anat. Physiol.
Anat. Studien	Anatomische Studien
Angers Acad. Sci. Mem	Memoires de l'Academie des Sciences et Belles-Lettres d'Angers
Angers, Ann. Soc. Linn	Annales de la Société Linneenne du departement de Maine et Loire
Angers, Mem. Soc. Agric.	Mémoires de la Société d'Agriculture, Sciences, et Arts
Angers, Soc. Sci. Bull.	Bulletin de la Société d'Etudes Scientifiques d'Angers
Ann.	Liebig's Annalen der Chemie
Ann. Bot.	Annals of Botany
Ann. Chim.	Annales de Chimie
Ann. Chim. anal.	Annales de Chimie analytique appliquee à l'Industrie, à l'Agriculture, à la Pharmacie et à la Biologie
Ann. chim. farm.	Annali di Chimica e de farmacologia
Ann. Chim. Phys.	Annales de Chimie et de Physique
Ann. Chimica	Annali di Chimica (Medico-Farmaceutica e di Farmacologia)
Ann. Conduct. Ponts et Chauss.	Annales des Conducteurs des Ponts et Chaussees et des Gardes-Mines
Ann. Conserv. Arts Met.	Annales du Conservatoire des Arts et Metiers
Ann. Dermatol.	Annales de Dermatologie et de Syphiligraphie
Ann. Ecole norm.	Annales scientifiques de l'Ecole Normale superieure (L. Pasteur)
Ann. Falsif.	Annales des Falsifications
Ann. Farm. Chim	Annali di Farmacoterapia e Chimica (Biologica)
Ann. Fis. Chim.	Annali di Fisica, Chimica, etc.
Ann. Génie Civil	Annales du Génie Civil
Ann. Gén. Sci. Phys.	Annales générales des Sciences Physiques
Ann. Geogr.	Annales de Geographie
Ann. Hydrogr.	Annales Hydrographiques
Ann. Hydrogr. Mar. Met.	Annalen der Hydrographie und Maritimen Meteorologie. Organ des Hydrographischen Bureaus (Amtes) und der Deutschen Seewarte
Ann. hyg. pub.	Annales d'hygiene publique
Ann. Ind.	Annales industrielles, par Fredureau, etc.
Ann. Inst. Pasteur	Annales de l'Institut Pasteur
Ann. Landw.	Annalen der Landwirtschaft in den K. Staaten
Ann. Landw. Wochenbl.	Annalen der Landwirtschaft, Wochenblatt
Ann. Mag. Natur. Hist.	The Annals and Magazine of Natural History, including Zoology, Botany and Geology

• Ann. Matemat.	Annali di Matematica pura ed applicata
Ann. Math.	Annals of Mathematics
Ann. Med.	Annali di Medicina
Ann. Med. Psychol.	Annales medico-psychologiques; Journal de l'anatomie, Physiologie, etc., du système nerveux
Ann. Med. Surg.	Annals of Medicine and Surgery, or Records of the occurring Improvements and Discoveries in Medicine, Surgery, and their immediately connected Arts and Sciences
Ann. Microg.	Annales de Micrographie spécialement consacrées à la Bactériologie, aux Protophytes et aux Protozoaires
Ann. Mines	• Annales des Mines. . . rédigées et publiées sous l'Autorisation du Ministre des Travaux Publics
Ann. Museo Ind. Ital. •	Annali del R. Museo Industriale Italiano
Ann. Natur. Hist.	Annals of Natural History
Ann. Oculist.	Annales d'Oculistique et de Gynecologie
Ann. Pharm.	Annals of Pharmacy
Ann. Pharm. Louvain	Annales de Pharmacie, Louvain
Ann. Phil.	Annals of Philosophy
Ann. Phys.	Annalen der Physik
Ann. Phys. Chem.	Annalen der Physik und Chemie
Ann. Ponts et Chauss.	Annales des Ponts et Chaussées
Ann. R. Staz. Chim.	Annali della R. Stazione Chimico Agraria Sperimentale di Roma
Ann. Rep., • U. S. Dept. Agric.	Annual Report of the United States Department of Agriculture
Ann. sci. agron.	Annales de la science agronomique française et étrangère
Ann. Sci. Bot. Nat.	Annales des Sciences Naturelles, Botanique
Ann. Sci. Lomb. Veneto	Annali delle Scienze del Regno Lombardo-Veneto
Ann. Sci. Nat.	Annales des Sciences Naturelles. Botanique, Zoologie et Paléontologie, comprenant l'Anatomie, la Physiologie, la Classification et l'Histoire Naturelle des Animaux
Ann. Sci. Univ. Jassy	Annales scientifiques de l'Université de Jassy
Ann. Scott. Natur. Hist.	The Annals of Scottish Natural History
Ann. Surg.	Annals of Surgery
Ann. Storia Natur.	Annali di Storia Naturale
Ann. Tel. gr.	Annales Télégraphiques
Annab.-Buchh. Ver. Naturk. Ber.	Bericht über den Annaberg-Buchholzer Verein für Naturkunde
Annab.-Buchh. Ver. Naturk. Jahr.	Jahresbericht des Annaberg-Buchholzer Vereins für Naturkunde
Annaes Sci. Natur.	Annaes de Sciencias Naturaes
Année Biol.	L'Année Biologique. Comptes Rendus annuels des Travaux de Biologie Générale
Annot. Zool. Jap.	Annotationes Zoologicae Japonenses, Auspiciis Societatis Zoologicae Tokyongensis seriatim editae
Annuaire Ancienne Normandie	Annuaire des cinq Départements de l'Ancienne Normandie, par l'Association Normandie
Annuaire Inst. Provinces	Annuaire de l'Institut des Provinces, des Sociétés Savantes, et des Congrès Scientifiques
Annuaire met. France	Annuaire Meteorologique de la France
Annuaire Mines Russie	Annuaire du Journal des Mines de Russie
Anthropol. (Paris)	• Matériaux pour l'Histoire de l'Homme. Revue d'Anthropologie. Revue d'Ethnographie réunies.
Anthropol. Congr.	See Congr. Int. Anthropol. C. R.
Anthropol. Inst. J.	The Journal of the Anthropological Institute of Great Britain and Ireland

Anthropol. Rev.	The Anthropological Review
Anthropol. Soc. Mem.	Memoirs read before the Anthropological Society of London
Antwerpen, Verh. Genoots. Occ. quinquenn.	Verhandelingen van het Genootschap. "Oecidit qui non servat"
Anvers, Ann. Soc. Med.	Annales de la Société de Médecine d'Anvers
Anvers, Congr. Sci. Geogr.	Compte-Rendu du Congrès des Sciences Géographiques, Cosmographiques et Commerciales
Anvers, J. Pharm.	Journal de Pharmacie, publ. par la Soc. de Pharmacie d'Anvers
Apoth. Ztg.	Apotheker Zeitung, Berlin
Apothecary	Apothecary, Boston
Appreturzeitung	Appreturzeitung
Art. Ann. Soc. Sci.	Annales de la Société littéraire, scientifique et artistique d'Art (Vaucluse)
Aquila	Aquila. A Magyar Ornithologiai Közvető Folyóirat. Periodical of Ornithology
Arb. Kais. Gesundhts.	Arbeiten aus dem kaiserlichen Gesundheitsamte, Berlin
Arb. pharm. Inst., D. Univ. Berlin	Arbeiten aus dem pharmazeutischen Institut der Universität Berlin
Arcachon Soc. Sci. Stat. Zool. Trav.	Société Scientifique et Station Zoologique d'Arcachon
Arctet. Oss. Pubbl.	See Firenze R. Ist. Pubbl. (Arctet. Oss.)
Archief Suikerind.	Archief Suikerindustrie in Nederlandsch Indië
Archief Wisk. Genoots.	Archief uitgegeven door het Wiskundig Genootschap
Archit. and Eng.	Architect and Engineer
Archiv. Agriculturchem.	See Hermbstadt
Archiv. Anat. Micro.	Archives d'Anatomie Microscopique
Archiv. Anat. Physiol.	Archiv. für Anatomie, Physiologie und wissenschaftliche Medizin
Archiv. Anthropol.	Archiv. für Anthropologie. Organ der deutschen Gesellschaft für Anthropologie, Ethnologie und Urgeschichte
Archiv. Anthropol. Etnol.	Archivio per l'Anthropologia e la Etnologia
Archiv. Augenheilk.	Archiv. für Augenheilkunde
Archiv. Augen- u. Ohrenheilk.	Archiv. für Augen- und Ohrenheilkunde
Archiv. belges méd. mil.	Archives belges de médecine militaire
Archiv. Biol.	Archives de Biologie
Archiv. Bot. Nord. France	Archives Botaniques du Nord de la France
Archiv. Chem. Mikros.	Archiv. Chemie und Mikroskopie
Archiv. Cosmol.	Archives cosmologiques. Revue des Sciences Naturelles, avec leurs applications à la Médecine, à l'Agriculture, aux Arts, et à l'Industrie
Archiv. Dent.	Archives of Dentistry: A record of Dental knowledge; medical, surgical, microscopical, chemical, and mechanical
Archiv. Elect.	Archives de l'Electricité
Archiv. Entwickl. Organ.	Archiv. für Entwicklungsmechanik der Organismen
Archiv. exper. Path. Pharm.	Archiv. für experimentelle Pathologie und Pharmacologie
Archiv. Farmacol. sper. Roma	Archivio di Farmacologia sperimentale e Scienze affini. Roma
Archiv. fisiol.	Archivio di fisiologia
Archiv. gen. Med.	Archives generales de Médecine
Archiv. ges. Physiol.	Archiv. für die gesammte Physiologie des Menschen und der Thiere (Pflüger)
Archiv. Heilk.	Archiv der Heilkunde

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Archiv. Hyg.	Archiv. für Hygiene
Archiv. Internal Med.	Archives of Internal Medicine
Archiv. intl. pharmacodyn.	Archives internationales de pharmacodynamie et de thereapie
Archiv. Ital. Biol.	Archives Italiennes de Biologie. Revues, Résumés Reproductions des Travaux Scientifiques Italiens
Archiv. Kinderheilk.	Archiv. für Kinderheilkunde
Archiv. Math. Naturvid.	Archiv. for Mathematik og Naturvidenskab
Archiv. Math. Phys.	Archiv. der Mathematik und Physik
Archiv. Med.	Archives of Medicine
Archiv. Med. comparee.	See Rayer
Archiv. med. exp.	Archives de medecine experimentale et d'anatomie pathologique
Archiv. Med. Navale	Archives de Medecine Navale (et Coloniale)
Archiv. Med. Pharm. Militair.	Archives de Medecine et de Pharmacie Militaires
Archiv. Mikro. Anat.	Archiv. für Mikroskopische Anatomie (und Entwicklungsgeschichte)
Archiv. Miss. Sci.	Archives des Missions Scientifiques et Littéraires
Archiv. Naturgesch.	Archiv. für Naturgeschichte
Archiv. Naturk. (Dorpat)	Archiv. für die Naturkunde Liv-, Ehst- und Kurlands. Herausgegeben von der Dorpater Naturforscher-Gesellschaft
Archiv. Neerland.	Archives Neerlandaises des Sciences Exactes et Naturelles publies par la Societe Hollandaise des Sciences a Harlem
Archiv. Ohrenheilk.	Archiv. für Ohrenheilkunde
Archiv. Ophthalm.	Albrecht von Graefe's Archiv für Ophthalmologie
Archiv. Ophthalm. Otol.	Archives of Ophthalmology and Otology
Archiv. Otol.	Archives of Otology
Archiv. Parasit.	Archives de Parasitologie
Archiv. path. Anat.	Archiv für pathologische Anatomie und Physiologie und für klinische Medizin (Virchow's)
Archiv. Pharm.	Archiv. der Pharmacie; Archiv des Apothekervereins im nördlichen Deutschland.
Archiv. Pharm og Chemi	Archiv. de Pharmaci og Chemi, Copenhagen
Archiv. Physiol.	Archives de Physiologie Normale et Pathologique
Archiv. Psychiatr.	Archiv. für Psychiatrie und Nervenkrankheiten
Archiv. Sci.	Archives of Science and Transactions of the Orleans County Society of Natural Sciences
Archiv. sci. med.	Archivio per les scienze mediche
Archiv. Sci. Phys. Nat.	Bibliothèque Universelle. Archives des Sciences Physiques et Naturelles
Archiv. Sci. Pract. Med.	Archives of Scientific and Practical Medicine
Archiv. Slaves Biol.	Archives Slaves de Biologie
Archiv. Verdauungs-krankh.	Archiv. für Verdauungs-krankheiten
Archiv. Wiss. Heilk.	Archiv. des Vereins für gemeinschaftliche Arbeiten zur Förderung der wissenschaftlichen Heilkunde
Archiv. Wiss. Prakt. Thierheilk.	Archiv. für wissenschaftliche und praktische Thierheilkunde
Archiv. Zool. Anat. Fis.	Archivio per la Zoologia, l'Anatomia, e la Fisiologia
Archiv. Zool. Exper.	Archives de Zoologie Experimentale et Generale
Recueil. Mem. Phys.	Memoires de Physique et de Chimie de la Societe d'Arcueil
Argent. Inst. Geogr. Bol.	Boletin del Instituto Geografico Argentino
Argent. P.	Argentine Patent
Argent. Soc. Ci. An.	Anales de la Sociedad Cientifica Argentina

Arkiv. Kemi, Mineral. Geol.	Arkiv för Kemi, Mineralogi och Geologi
Arkiv. Math. Astron. Fysik	Arkiv för Matematik Astronomi och Fysik
Armagh Nat. Hist. & Phil. Soc.	See Irish Natlist.
Arms and Expl.	Arms and Explosives
Arnhem, Natuurk.	Natuurkunde. Tijdschrift, inhoudende Phijsica, Chemie, Pharmacie, Natuurlijke Historie en Litteratuur, uitgegeven van wege het Genootschap <i>Tot nut en vergenoegen</i> , te Arnhem
Arras, Mem. Acad	Memoires de l'Academie d'Arras
Arras, Mem. Soc. Roy.	Memoires de la Societe Royale d'Arras
Art. J.	The Art Journal
Art. J.	The Artizan (London)
Artus, Jahr. ökon. Chemie	Jahrbuch für ökonomische Chemie, etc
Artus, Vierteljahresschrift	Vierteljahresschrift für technische Chemie, Landwirthschaftliche Gewerbe, Fabrickwesen, und Gewerbetreibende überhaupt
Ashmole. Soc. Proc	Abstracts of the Proceedings of the Ashmolean Society
Asiat. Researches	Asiatic Researches, or Transactions of the (Bengal) Society
Asiat. Soc. J.	Journal of the Royal Asiatic Society
Assoc. Franc. Compt rend	Association Française pour l'avancement des Sciences. Comptes Rendus
Assoc. Med. J.	See Med. Assoc. Journ.
Assur. Mag.	The Assurance Magazine (and Journal of the Institute of Actuaries)
Astron. Nachr.	Astronomische Nachrichten
Astron. Soc. Mem	Memoirs of the Astronomical Society of London
Astron. Soc. Month Not.	Monthly Notices of the Astronomical Society of London
Astrophys. J.	Astrophysical Journal
Atelier Phot.	Atelier des Photographen
Ateneo Ital.	L'Ateneo Italiano
Athenes Obs. Nat. Ann	Annales de l'Observatoire National d'Athenes
Atlantis	The Atlantis, or Register of Literature and Science
Atti. Accad. Ital.	Atti dell'Accademia Italiana di Scienze
Atti. accad. Lincei	Atti della reale accademia dei Lincei, rediconti, classe di scienze fisiche, mathematiche e naturali
Atti. Coll. Ing. Archit	Atti de Collegio degli Ingegneri ed Architetti in Milano
Atti. inst. incoragg	Atti del R. istituto d'incoraggiamento di Napoli, Naples, Italy
Atti. R. Accad. Sci. Torino	Atti della Reale Accademia della Scienze di Torino
Atti Sci. Ital.	Riunione degli Scienziati Italiani
Atti Soc. Elvet.	Atti della Societa Elvetica delle Scienze Naturali
Aube, Mem. Soc. Agric	Memoires de la Societe d'Agriculture, des Sciences, et des Lettres du departement de l'Aube
Augsb. Naturhist. Ver. Ber.	Berichte des Naturhistorischen Vereins in Augsburg
Auk	The Auk. A Quarterly Journal of Ornithology
Ausland	Das Ausland
Aust. P.	Austrian Patent
Aust.-Hung. P.	Austro-Hungarian Patent
Australasian Assoc. Rep.	Report of the Meeting of the Australasian Association for the Advancement of Science
Australasian J. Pharm.	Australasian Journal of Pharmacy, Melbourne
Australian Med. J.	Australian Medical Journal

Australia Med. Rec.	Medical Records of Australia
Australian P.	Australian P.
Australian Sugar J.	Australian Sugar Journal
Autun, Mem. Soc. Eduenne	Memoires de la Societe Eduenne
Auvergne, Ann. Sci.	Annales Scientifiques, Litteraires, et Industrielles de l'Auvergne
Auxerre, Bull. Soc. Sci.	Bulletin de la Societe des Sciences Historiques et Naturelles de l'Yonne
Badischen Arzt. Verein.	Mittheilungen des Badischen ärztlichen Vereins
Mitth.	
Bah. P.	Bahamas Patent
Ballenstedt, Archiv.	Archiv für die neuesten Entdeckungen aus der Urwelt
Ballot, Mag. Landbouw.	Magazin voor Landbouw en Kruidkunde
Baltimore Med. Phys. Recorder.	Baltimore Medical and Physical Recorder
Bamb. Naturf. Ges. Ber.	Bericht der naturforschenden Gesellschaft zu Bamberg
Barb. P.	Barbados Patent
Barcelona Acad. Bol.	Boletin de la Real Academia de Ciencias y Artes de Barcelona
Barcelona Acad. Mem.	Memorias de la Real Academia de Ciencias Naturales y Artes de Barcelona
Barrow Field Club Report	Barrow Naturalists' Field Club and Literary and Scientific Association. Annual Report and Proceedings
Basel, Ber.	Bericht über die Verhandlungen der Naturforschenden Gesellschaft in Basel
Batavia Genootsch. Verh.	Verhandlingen van het Bataviaasch Genootschap der Kunsten en Wetenschappen
Batavia, Natuur. Archief.	Natuur- en Geneeskundig Archief voor Nederlandsch-Indië
Batavia, Natuurk. Tijdschr.	Natuurkundig 'Tijdschrift' voor Nederlandsch-Indië, uitgegeven door de Koninklijke Natuurkundige Vereeniging in Nederlandsch-Indië
Batavia, Notulen	Notulen van de Algemeene en Bestuurs-Vergaderingen van het Bataviaasch Genootschap van Kunsten en Wetenschappen
Batavia Obs. Obsns.	Observations made at the (Royal) Magnetical and Meteorological Observatory at Batavia
Batavia, Tijdschr.	Tijdschrift voor Indische Taal-, Land-, en Volkenkunde
Batavia, Verh. Natuurk. Vereen.	Verhandlingen der Natuurkundige Vereeniging in Nederlandsch-Indië
Bath Micro. Soc. Minutes	Extracts from the Minutes of the Bath Microscopical Society
Bath Natur. Hist. Club. Proc.	Proceedings of the Bath, Natural History and Antiquarian Field Club
Bath Soc. Agric. Letters	Letters and Papers of the Bath and West of England Society for the Encouragement of Agriculture, Arts, Manufactures, and Commerce
Baugew. Ztg.	Baugewerks-Zeitung
Baumgartner Zts.	Zeitschrift für Physik, Mathematik, und verwandte Wissenschaften
Bayer. Gewerbeztg.	Bayerische Gewerbezeitung
Bayer. Kunst. Gewerbebl.	Kunst und Gewerbeblatt (Poletechn. Verein Königreich Bayern)
Bayer, Landw. Ver. Bfg.	Ergebnisse landwirthschaftlicher und agrikulturchemischer Versuche an der Station des General-Comite des Bayerischen Landwirthschaftlichen Vereines in München

Bayeux, Mem. Soc. Agric.	Memoires de la Societe d'Agriculture, Sciences, Arts, et Belles-Lettres de Bayeux
Bd. Trade J.	Board of Trade Journal
Beauvais, Soc. Acad. Mem.	Memoires de la Societe Academique d'Archeologie, Sciences et Arts du Department de l'Oise
Beitr. Anat. Physiol.	See Eckhard
Beitr. Anthropol. Bayerns	Beitrage zur Anthropologie und Urgeschichte Bayerns. Organ der Munchener Gesellschaft für Anthropologie, Ethnologie und Urgeschichte
Beitr. Biol. Pflanz.	Beitrage zur Biologie der Pflanzen
Beitr. Geophys.	Beitrage zur Geophysik. Abhandlungen aus dem Geographischen Seminar der Universität Strassburg. Beitrage zur Geophysik. Zeitschrift für Physikalische Erdkunde
Beitr. Kryptog. Schweiz	Beitrage zur Kryptogamenflora der Schweiz
Beitr. Mecklenb. Aerzte	Beitrage Mecklenburgischer Aerzte zur Medicin und Chirurgie
Beitr. Morphol.	Beitrage zur Morphologie und Morphogenie. Untersuchungen aus dem Anatomischen Institut zu Erlangen
Beitr. Naturk. Preussens	Beitrage zur Naturkunde Preussens. Herausgegeben von der Koniglichen Physikalisch-Oekonomischen Gesellschaft zu Königsberg
Beitr. Paläont. Oesterr.-Ung.	Beitrage zur Palaontologie Oesterreich-Ungarns und des Orients
Beitr. Path. Anat.	Beitrage zur Pathologischen Anatomie und Physiologie. Beitrage zur Pathologischen Anatomie und zur Allgemeinen Pathologie
Beitr. Physiol. Morphol.	Beitrage zur Physiologie und Morphologie Niederer Organismen.
Beitr. Russ Reich.	Beitrage zur Kenntniss des Russischen Reiches und der angrenzenden Lander Asiens
Belfast, Clin. Soc. Trans.	Transactions of the Clinical and Pathological Society of Belfast
Belfast Field Club Rep.	Annual Reports and Proceedings of the Belfast Naturalists' Field Club
Belfast Natur. Hist. Soc. Proc.	Proceedings of the Belfast Natural History and Philosophical Society
Belg. Horticole	La Belgique Horticole. Annales de Botanique et d'Horticulture
Belg. P.	Belgian Patent
Bengal Asiat. Soc. J.	Journal of the Asiatic Society of Bengal
Bengal Asiat. Soc. Proc.	Proceedings of the Asiatic Society of Bengal
Bengal Govt. Records	Selections from the Records of the Bengal Government
Bengal, Phot. Soc. J.	Journal of the Photographic Society of Bengal
Ber.	Berichte der Deutschen Chemischen Gesellschaft, Berlin
Ber. deut. bot. Ges.	Berichte der deutschen botanischen Gesellschaft
Ber. pharm. Ges.	Berichte der deutschen pharmazeutischen Gesellschaft
Ber. phys. Ges.	Berichte der deutschen physikalischen Gesellschaft
Ber. Sächs. Ges. Wiss.	Berichte über die Verhandlungen der Königl. Sachs. Gesellschaft der Wissenschaften zu Leipzig
Ber. Veter. König. Sach.	Berichte über das Veterinarwesen im Königreich Sachsen
Berg. Hüttenm. Jahr.	Berg- und hüttenmannisches Jahrbuch
Berg. Hüttenm. Ztg.	Berg- und hüttenmannische Zeitung

Bergens Mus. Aarb.	Bergens Museums Aarvog for... Afhandlinger og Aarsberetning udgivne af Bergens Museum
Berggeist	Der Berggeist
Berghaus, Ann.	Annalen der Erdk. Völker- und Staatenkunde
Berghaus, Zts. Erdk.	Zeitschrift für vergleichende Erdkunde
Berlin Afrik. Ges. Mitth.	Mittheilungen der Afrikanischen Gesellschaft in Deutschland
Berlin Akad. Abh.	Abhandlungen der k. Akademie der Wissenschaften zu Berlin
Berlin Akad. Monatsber.	Monatsberichte der k. Preussischen Akademie der Wissenschaften zu Berlin
Berlin Akad. Sitzber.	Sitzungsberichte der Königlich Preussischen Akademie der Wissenschaften zu Berlin
Berlin Ann. Telegr.	Annalen der Telegraphie
Berlin Astron. Anst.	Berliner Astronomisches Jahrbuch
Berlin Bot. Gartens Jahr.	Jahrbuch des Königl. Botanischen Gartens und des Botanischen Museums zu Berlin
Berlin Bot. Gartens Notizbl.	Notizblatt des Königl. Botanischen Gartens und Museums zu Berlin
Berlin Ent. Ges.	See Ill. Wschr. Ent.
Berlin Entom. Zts.	Berliner Entomologische Zeitschrift; herausg. von dem Entomologischen Verein in Berlin
Berlin Ges. Anthropol. Verh.	See Ztschr. Ethnol.
Berlin Ges. Erdk. Verh.	Verhandlungen der Gesellschaft für Erdkunde zu Berlin
Berlin Ges. Erdk. Zts.	See Berlin Zts. Erdk.
Berlin Ges. Geburtshlf. Gynäk.	See Zts. Geburtshlf. Gynäk.
Berlin Ges. Naturf. Freunde Mag.	Magazin der Gesellschaft Naturforschender Freunde zu Berlin, für die neuesten Entdeckungen in der gesammten Naturkunde
Berlin Ges. Naturf. Freunde N. Schr.	Neue Schriften der Gesellschaft Naturforschender Freunde in Berlin
Berlin Ges. Naturf. Freunde Verh.	Verhandlungen der Gesellschaft Naturforschender Freunde zu Berlin
Berlin Ges. Psychiatr.	See Arch. Psychiatr.
Berlin Gesundheitsamt Biol. Abth. Arb.	Arbeiten aus der Biologischen Abtheilung für Land- und Forstwirtschaft am Kaiserlichen Gesundheitsamte
Berlin Ind. Ztg.	Industrie Zeitung, Berlin
Berlin Jahr. Pharm.	Berlinisches Jahrbuch für die Pharmacie und für die damit verbundenen Wissenschaften
Berlin Klin. Wochenschr.	Berliner klinische Wochenschrift
Berlin Mem. Acad.	Memoires de l'Academie Royale des Sciences de Berlin
Berlin Mitth. Ges. Naturf.	Mittheilungen aus den Verhandlungen der Gesellschaft Naturforschender Freunde zu Berlin
Berlin Monatsber.	Monatsberichte der K. Preuss. Akademie der Wissenschaften zu Berlin
Berlin Monatsber. Ges. Erdk.	Monatsberichte über die Verhandlungen der Gesellschaft für Erdkunde zu Berlin
Berlin Naturf. Freunde Sitzber.	Sitzungs-Berichte der Gesellschaft Naturforschender Freunde zu Berlin
Berlin Neue Zts. Geburtsk.	Neue Zeitschrift für Geburtskunde
Berlin Physiol. Ges. Verh.	See Arch. Anat. Physiol.
Berlin Physik. Reichsanst. Abh.	Wissenschaftliche Abhandlungen der Physikalisch Technischen Reichsanstalt
Berlin Verh. Med. Ges.	Verhandlungen der Berliner medicinischen Gesellschaft

Berlin Zool. Mus. Mitth.	Mittheilungen aus der Zoologischen Sammlung des Museums für Naturkunde in Berlin
Berlin Zts. Erdk.	Zeitschrift der Gesellschaft für Erdkunde zu Berlin
Berlin Mitth.	Mittheilungen der Naturforschenden Gesellschaft in Bern
Berwick, Natur. Club Hist.	History of the Berwickshire Naturalists' Club
Berz. Jahr. Chem.	Berzelius Jahresberichte der Chemie
Besancon, Mem. Soc. Emul.	Memoires et Comptes Rendus de la Societe (Libre) d'Emulation du Doubs
Besancon, Seances Publ.	Seances publiques de l'Academie des Sciences, Arts, et Belles-Lettres de Besancon
Beton Eisen	Beton und Eisen
Betterave	Betterave
Beziers Soc. Sci. Bull.	Bulletin de la Société d'Etude des sciences naturelles de Beziers
Bianconi, Rep Ital.	Repertorio Italiano Per la Storia Naturale
Bibl. Anat.	Bibliographie Anatomique. Revue des Travaux en langue française. Anatomie. Histologie. Embryologie. Anthropologie
Bibl. Bot.	Bibliotheca Botanica. Abhandlungen aus dem Gesamtgebiete der Botanik
Bibl. Brit.	Bibliothèque Britannique, ou Recueil extrait des Ouvrages Anglais periodiques et autres; partie des Sciences et Arts
Bibl. Ital.	Giornale dell' I. R. Istituto Lombardo di Scienze, Lettere ed Arti, e Biblioteca Italiana
Bibl. Math.	Bibliotheca Mathematica. Zeitschrift für Geschichte der Mathematik. Journal d'Histoire des Mathematiques. Bibliotheca Mathematica. Zeitschrift für Geschichte der mathematischen Wissenschaften
Bibl. Univ.	Bibliothèque Universelle des Sciences, Archives des Sciences Physiques et Naturelles
Bibl. Zool.	Bibliotheca Zoologica
Bied. Zentr.	Biedermann's Zentralblatt für Agrikulturchemie und rationellen Landwirtschafts-Betrieb
Bierbrauer	Der Bierbrauer
Bijdr. tot de Dierkunde	Bijdragen tot de Dierkunde
Biochem. Bull.	Biochemical Bulletin
Biochem. J.	The Bio-Chemical Journal
Biochem. Zentr.	Biochemisches Zentralblatt, Leipzig
Biochem. Zts.	Biochemische Zeitschrift
Biol. Bull.	Biological Bulletin
Biol. Zentr.	Biologisches Zentralblatt
Biophys. Zentr.	Biophysikalisches Zentralblatt, Leipzig
Birmingham Natur. Hist. & Micro. Soc. Trans.	See Midland Natlist Trans.
Birmingham Phil. Soc. Proc.	Proceedings of the Birmingham Philosophical Society
Blankenburg, Ber.	Berichte des Naturwissenschaftlichen Vereins des Harzes zu Blankenburg
Blätter Blech-Arb.	Deutsche Blätter für Blecharbeiter
Blätter Kunstgew.	Blätter für Kunstgewerbe
Blätter Zuckerrüb.	Blätter für Zuckerrübenbau
Bleekrode, Nieuw Tijdschrift	Nieuw Tijdschrift gewijd aan alle takken van Volkswijet, Nijverheid, Landbouw, Mijnwezen, Handel, Spoorwegen, Telegraphie en Scheepvaart
Blois, Mem. Soc. Sci.	Memoires de la Société des Sciences et des Lettres de Blois
Blois, Soc. Loir et Cher Mem.	Memoires de la Société des Sciences et Lettres de Loir et Cher

Boerhaave	Boerhaave
Böhm. Ges. Abh.	Abhandlungen der Königlich Böhmischen Gesellschaft der Wissenschaften
Böhm. Ges. Wiss. Jahr.	Jahresbericht der königl. böhm. Gesellschaft der Wissenschaften
Bohm. Monatschr. Ges. Mus.	Monatschrift des Gesellschaft des Vaterländischen Museums in Böhmen
Bol. P.	Bolivia Patent
Boll. chim. farm.	Bolletino chimico farmaceutico, Milan
Boll. estac. agr. Ciudad Juarez	Boletin de la estacion agricola experimental de Ciudad Juarez
Boll. ingen.	Boletin de ingenieros
Boll. Natur. Siena	Bollettino del Naturalista Collettore, Allevatore Coltivatore
Bologna Accad. Sci. Mem.	Memorie della (R.) Accademi delle Scienze dell'Istituto di Bologna
Bologna, Mem. Inst. Naz. Ital.	Memorie dell'Istituto Nazionale Italiano
Bologna, Mem. Soc. Med.	Memorie della Societa Medica di Bologna
Bologna, Mem. Soc. Med. Chir.	Memorie della Societa Medico-chirurgica di Bologna
Bologna, Nov. Comment.	Novi Commentarii Academiae Scientiarum Instituti Bononiensis
Bologna, Opusc.	Opuscoli della Societa Medico-chirurgica di Bologna
Bologna, Opusc. Sci.	Opuscoli Scientifici
Bologna, Opusc. Sci. N. Coll.	Nuova collezione d'Opuscoli Scientifici
Bologna Rend.	Rendiconto delle Sessioni dell' Accademia Reale delle Scienze dell' Istituto di Bologna
Bombay, Agric. Hort. Soc. Proc.	Proceedings of the Agricultural and Horticultural Society of Western India
Bombay Govt. Records	Selections from the Records of the Bombay Government
Bombay, Med. Phys. Soc. Trans.	Transactions of the Medical and Physical Society of Bombay
Bombay Natur. Hist. Soc. J.	The Journal of the Bombay Natural History Society
Bombay, Roy. Asiat. Soc. J.	The Journal of the Bombay Branch of the Royal Asiatic Society
Bone, Acad. Hippone Bull.	Bulletin de l'Academie d'Hippone
Bonn, Corresp. Blatt Nat. Hist. Ver.	Correspondenzblatt des Naturhistorischen Vereins für Rheinland und Westphalen
Bonn, Niederrhein. Ges. Sitzber.	Sitzungsberichte der Niederrheinischen Gesellschaft für Natur- und Heilkunde zu Bonn
Bonn, Untersuch. Physiol. Lab.	Untersuchungen aus dem physiologischen Laboratorium zu Bonn
Bonn, Verh. Naturhist. Ver.	Verhandlungen des Naturhistorischen Vereins der Preussischen Rheinlande und Westphalens
Bonplandia	Bonplandia
Bordeaux, Acad. Sci. Seances Publ.	Seances publiques de l'Academie Royale des Sciences, Belles-Lettres, et Arts de Bordeaux
Bordeaux, Actes Acad. Sci.	Recueil des Actes de l'Academie des Sciences, Belles-Lettres, et Arts de Bordeaux
Bordeaux, J. Med.	Journal de Medecine de Bordeaux
Bordeaux, J. Med. Prt.	Journal de Medecine pratique, ou Recueil des Travaux de la Société de Medecine de Bordeaux
Bordeaux, Mem. Soc. Med. Chir.	Memoires et Bulletins de la Société Medico-Chirurgicale des Hopitaux et Hospices de Bordeaux
Bordeaux, Mem. Soc. Sci. Phys.	Memoires de la Société des Sciences Physiques et Naturelles de Bordeaux

Bordeaux, Soc. Linn. Actes	Actes de la Société Linneenne de Bordeaux
Bordeaux, Soc. Linn. Bull.	Bulletin d'Histoire Naturelle de la Société Linneenne de Bordeaux
Bordeaux, Soc. Med. Mem.	Memoires et Bulletins de la Société de Médecine et de Chirurgie de Bordeaux
Bordeaux, Soc. Sci. P.-V.	Procès-Verbaux des Séances de la Société des Sciences Physiques et Naturelles de Bordeaux
Bornemann, Der Ingenieur	Der Ingenieur
Boston J. Phil.	The Boston Journal of Philosophy and the Arts
Boston J. Natur. Hist.	Boston Journal of Natural History
Boston Med. Surg. J.	Boston Medical and Surgical Journal
Boston, Mem. Amer. Acad.	Memoirs of the American Academy of Arts and Sciences
Boston, Mem. Natur. Hist. Soc.	Memoirs read before the Boston Society of Natural History
Boston Pap. Soc. Natur. Hist.	Occasional papers of the Boston Society of Natural History
Boston, Proc. Natur. Hist. Soc.	Proceedings of the Boston Society of Natural History
Boston Soc. Med. Sci. J.	Journal of the Boston Society of Medical Sciences
Bot. Centr.	Botanisches Centralblatt. Referirendes Organ für das Gesamtgebiet der Botanik des In- und Auslandes
Bot. Centr. Beihefte	Beihefte zum Botanischen Centralblatt
Bot. Cong. Proc.	The International Horticultural Exhibition and Botanical Congress: Report of Proceedings
Bot. Gaz.	The Botanical Gazette
Bot. Jahr. (Engler)	Botanische Jahrbücher, Engler, Leipzig
Bot. Mag., Tokyo	The Botanical Magazine, Tokyo
Bot. Notiser	Botaniska Notiser
Bot. Tidsskr.	Botanisk Tidsskrift udgivet af den Botaniske Forening i Kjøbenhavn
Bot. Untersuch.	Botanische Untersuchungen aus dem Physiologischen Laboratorium der landwirthschaftlichen Lehranstalt in Berlin
Bot. Untersuch. (Brefeld's)	Untersuchungen aus dem Gesamtgebiete der Mykologie
Bot. Ver. Gesamtthüringen	See Jena Geogr. Ges. Mitth.
Botan. Ztg.	Botanische Zeitung
Bot. Zentr.	Botanisches Zentralblatt
Botaniste	Le Botaniste
Bouchardat, Archiv.	Archives de Physiologie, de Therapeutique, et d'Hygiène
Boue, J. Geol.	Journal de Geologie
Boulogne, Mem. Soc. Agric.	Memoires de la Société d'Agriculture, etc., de Boulogne-sur-Mer
Bourse cuirs Liege	Bourse aux cuirs de Liege, bulletin hebdomadaire
Brandenb. Bot. Ver. Verh.	Verhandlungen des botanischen Vereins für die Provinz Brandenburg
Brass World	Brass World and Platers Guide, The
Braunk.	Braunkohle
Braunschw. Ver. Naturwiss. Jahr.	Jahresbericht des Vereins für Naturwissenschaft zu Braunschweig
Braz. P.	Brazilian Patent
Bremen Abb.	Abhandlungen herausgegeben vom Naturwissenschaftlichen Verein zu Bremen
Brenn. Ztg.	Brennerei Zeitung
Brera, Giorn. Med. Prat.	Giornale di Medicina Pratica
Brera, Nuovi Comment.	Nuovi Commentari di Medicina

Brescia, <i>Comment. Atenco</i>	<i>Commentarij della Accademia di Scienze, Lettere, ed dell'Atenco di Brescia</i>
Breslau, <i>Ann. Klin. Inst.</i>	<i>Annalen des Klinisch-chirurgischen Instituts auf der Universität zu Breslau</i>
Breslau, <i>Bot. Garten Arb.</i>	<i>Arbeiten aus dem Konigl. Botanischen Garten zu Breslau</i>
Breslau, <i>Gewerbebl.</i>	<i>Breslauer Gewerbeblatt</i>
Breslau, <i>Jahr. Schles. Ver. Berg.</i>	<i>Jahrbuch des Schlesischen Vereins für Berg- und Hüttenwesen</i>
Breslau, <i>Schles. Ges. Jahr.</i>	<i>Jahresbericht des Akademischen Naturwissenschaftlichen Vereins zu Breslau</i>
Breslau, <i>Studien Physiol. Inst.</i>	<i>Studien des Physiologischen Instituts zu Breslau</i>
Breslau, <i>Zts. Klin. Med.</i>	<i>Zeitschrift für Klinische Medicin</i>
Brest Soc. <i>Acad. Bull.</i>	<i>Bulletin de la Société Académique de Brest</i>
Brewers J. (Lon.)	<i>Brewers' Journal and Hop and Malt Trades Review, The (London)</i>
Brewers J., N. Y.	<i>Brewers Journal, New York</i>
Brick	<i>Brick</i>
Brick J.	<i>Brick, Pottery and Glass Journal</i>
Brick and Clay Record	<i>Brick and Clay Record</i>
Brighton, <i>Proc. Natur. Hist. Soc.</i>	<i>Reports and Abstracts of the Proceedings of the Brighton and Sussex Natural History Society</i>
Bristol <i>Proc. Nat. Soc.</i>	<i>Proceedings of the Bristol Naturalists' Society</i>
Brit. Assoc. Rep.	<i>Report of the Meetings of the British Association for the Advancement of Science</i>
Brit. Clay Worker	<i>British Clay Worker, The</i>
Brit. Food J.	<i>British Food Journal</i>
Brit. For. Med. Chir. Rev.	<i>British and foreign Medico-Chirurgical Review</i>
Brit. Inst. Publ. Health	<i>See J. State Med.</i>
Brit. J. Almanac	<i>British Journal of Photography Almanac</i>
British J. Dent. Sci.	<i>The British Journal of Dental Science</i>
Brit. J. Phot.	<i>British Journal of Photography</i>
Brit. Med. J.	<i>British Medical Journal</i>
Brit. Mycol. Soc. Trans.	<i>The British Mycological Society. Transactions</i>
Brit. Pharm. Confer. Proc.	<i>Proceedings of the British Pharmaceutical Conference</i>
Brit. Pharm. Confer. Trans.	<i>Year Book of Pharmacy, comprizing Abstracts of Papers With the Transactions of the British Pharmaceutical Conference</i>
Brit. Colon. Drug.	<i>British and Colonial Druggist, London</i>
Brit. Guiana Agr. Soc.	<i>See Timchri</i>
Brit. Guiana P.	<i>British Guiana Patent</i>
Brit. Hond. P.	<i>British Honduras Patent</i>
Brooklyn Entom. Soc. Bull.	<i>Bulletin of the Brooklyn Entomological Society</i>
Brosche, Zts.	<i>Zeitschrift für Natur- und Heilkunde</i>
Broussais, Ann.	<i>Annales de la Médecine Physiologique</i>
Brown-Sequard, J. <i>Physiol.</i>	<i>Journal de la Physiologie de l'Homme et des Animaux</i>
Brugnatelli, Giorn.	<i>Giornale di Fisica, Chimica, e Storia Naturale</i>
Brunn Verh.	<i>Verhandlungen des Naturforschenden Vereines in Brunn</i>
Brux. Acad. Bull.	<i>Bulletins de l'Académie Royale des Sciences, etc., de Belgique</i>
Brux. Acad. Cent. Anniv.	<i>Cinquième Anniversaire de Fondation de l'Académie Royale de Belgique</i>
Brux. Acad. Med. Belg. Bull.	<i>Bulletin de l'Académie Royale de Médecine Belgique</i>
Brux. Acad. Sci. Mem.	<i>Nouveaux mémoires de l'Académie Royale, des Sciences et Belles-lettres de Bruxelles</i>

Brux. Actes Soc. Med.	Actes de la Société Médicale de Bruxelles
Brux. Ann. Soc. Entom. Belge	Annales de la Société Entomologique Belge
Brux. Ann. Soc. Malacol.	Annales de la Société Malacologique de Belgique
Brux. Ann. Trav. Pub.	Annales des Travaux Publiques de Belgique
Brux. Ann. Univ. Belg.	Annales des Universités de Belgique
Brux. Bull. Belge Phot.	Bulletin Belge de la Photographie
Brux. Bull. Soc. Bot.	Bulletins de la Société Royale de Botanique de Belgique
Brux Congr. Bot. Act.	Actes du Congrès de Botanique horticole réuni à Bruxelles
Brux Congr. Bot. (C. R.)	Congrès de Botanique et d'Horticulture de 1880 tenu à Bruxelles
Brux. J. Med.	Journal de Médecine, de Chirurgie, et de Pharmacologie
Brux. J. Soc. Centr. Agric.	Journal de la Société Centrale d'Agriculture de Belgique
Brux. Mem. Couronn.	Mémoires Couronnés et Mémoires des Savants Etrangers
Brux. Mus. Congo Ann.	Etat Indépendant du Congo. Annales du Musée du Congo, publiées par ordre du Secrétaire d'Etat
Brux. Mus. Hist. Natur. Ann.	Annales du Musée Royal d'Histoire Naturelle de Belgique
Brux. Mus. Hist. Natur. Bull.	Bulletin du Musée Royal d'Histoire Naturelle de Belgique
Brux. Mus. Hist. Natur. Mem.	Mémoires du Musée Royal d'Histoire Naturelle de Belgique
Brux. Soc. Agric. Journ.	Journal de la Société Centrale d'Agriculture de Belgique
Brux. Soc. Belge Micro Ann.	Annales de la Société Belge de Microscopie
Brux. Soc. Belge Micro Bull.	Bulletin (des Séances) de la Société Belge de Microscopie
Brux. Soc. Entom. Ann.	Annales de la Société Entomologique de Belgique
Brux. Soc. Entom. Mem.	Mémoires de la Société Entomologique de Belgique
Brux. Soc. Linn. Bull.	Bulletin de la Société Linnéenne de Bruxelles
Brux. Soc. Sci.	See Rev. Quest. Sci.
Brux. Soc. Sci. Ann.	Annales de la Société Scientifique de Bruxelles
Bucarest Acad. Rom. Anal.	Analele Academiei Române
Bucarest Soc. Sci. Bul.	Buletinul Societății de Științe (Fizică, Fiziologie, Chimie și Mineralogie) din București-România. Bulletin de la Société des Sciences, Bucarest-Roumanie
Büchholz	See Annab.-Buchh. Ver. Nat. Jber.
Buda, Evkonyvei	A' Magyar Tudós Társaság' Evkonyvei (Year Books of the Hungarian Scientific Association)
Buda, Palyamunkak.	Természettudományi Pályamunkák
Buda, Tudománytar.	Tudománytar Közre hozatja a' Magyar Tudós Társaság
Buffalo Bull.	Bulletin of the Buffalo Society of Natural Sciences
Builder	The Builder
Buitenzorg Inst. Bot. Bull.	's Lands Plantentuin. Bulletin de l'Institut Botanique de Buitenzorg
Buitenzorg Jard. Bot. Ann.	Annales du Jardin Botanique de Buitenzorg
Bull. Acad. Med.	Bulletin of the Academy of Medicine
Bull. Acad. roy. Belg.	Académie royale de Belgique; Bulletin de la Classe des Sciences
Bull. Acad. Sci., Cracow.	Bulletin international de l'Académie des Sciences de Cracovie

Bull. Acad. Sci., Petrograd	Bulletin de l'Académie Impériale des Sciences de Petrograd
Bull. Amer. Inst. Min. Eng.	Bulletin American Institute of Mining Engineers
Bull. Amer. Pharm. Assoc.	Bulletin of the American Pharmaceutical Association
Bull. assoc. chim. sucr. dist.	Bulletin de l'association des chimistes de sucrerie distillerie de France
Bull. Bur. Agric.	Bulletin of the Bureau of Agricultural Intelligence and of Plant Diseases
Bull. Bur. Chem. U. S. Dept. Agric.	Bulletins, Bureau of Chemistry, U. S. Department of Agriculture
Bull. Bur. Mines	Bureau of Mines Bulletin, Department of the Interior
Bull. Bur. Standards	Bulletin of the Bureau of Standards
Bull. Col. Sch. of Mines	Bulletin of the Colorado School of Mines
Bull. Dept. Agric. Jamaica	Bulletin of the Department of Agriculture, Jamaica
Bull. Dept. Agric. Trinidad	Bulletin of Agricultural Information, Department of Agriculture, Trinidad
Bull. Geol. Inst. Univ. Upsala	Bulletin of the Geological Institute of the University of Upsala
Bull. Geol. Soc. Amer.	Bulletin of the Geological Society of America
Bull. Hyg. Lab.	Bulletins of the Hygienic Laboratory, United States Public Health and Marine Hospital Service
Bull. Imp. Inst.	Bulletin of the Imperial Institute, London
Bull. Iron Assoc.	Bulletin of the American Iron and Steel Association
Bull. Johns Hopkins Hosp.	Bulletin of Johns Hopkins Hospital
Bull. Mass. Inst. Tech.	Bulletin of the Massachusetts Institute of Technology
Bull. Med. Belge.	Bulletin Medical Belge.
Bull. Musée	Bulletin du Musée de l'Industrie de Belgique
Bull. Pharmacie	Bulletin de Pharmacie
Bull. Pharmacy	Bulletin of Pharmacy
Bull. Pharm. Sud-est	Bulletin de Pharmacie du Sud-est, Montpellier
Bull. Sci. France Belg.	Bulletin Scientifique de la France et de la Belgique
Bull. Sci. Nord	Bulletin Scientifique, Historique et Littéraire du Département du Nord et des pays voisins
Bull. Sci. pharmacolog.	Bulletin des Sciences pharmacologiques
Bull. Soc. Bot. France	Bulletin de la Société Botanique de France
Bull. Soc. Bot. Belg.	Bulletin de la Société Royale de Botanique de Belgique
Bull. Soc. Chim.	Bulletin de la Société Chimique de France
Bull. Soc. Chim. Belg.	Bulletin de la Société Chimique de Belgique
Bull. Soc. Encourag.	Bulletin de la Société d'Encouragement
Bull. Soc. franc. Mineral.	Bulletin de la Société Française de Mineralogie
Bull. Soc. franc. Phot.	Bulletin de la Société Française de Photographie
Bull. Soc. geol. France	Bulletin de la Société géologique de France
Bull. Soc. Ind. Amiens	Bulletin de la société industrielle d'Amiens
Bull. Soc. Ind. Marseille	Bulletin de la Société industrielle de Marseille
Bull. Soc. Ind. Minerale	Bulletin de la société de l'industrie minière
Bull. Soc. Ind. Mulh.	Bulletin de la société industrielle de Mulhouse
Bull. Soc. Ind. Nord	Bulletin mensuel de la société industrielle du Nord
Bull. Soc. Ind. Rouen	Bulletin de la société industrielle de Rouen
Bull. Soc. internat. elect.	Bulletin de la Société internationale des electriciens
Bull. Soc. Med. Amiens	Bulletin des Travaux de la Société Médicale d'Amiens
Bull. Soc. med. Gand	Bulletin de la Société de Médecine de Gand
Bull. Soc. Mycol.	Bulletin de la Société Mycologique de France
Bull. Soc. pharm. Bord.	Bulletin de la société pharmacie de Bordeaux
Bull. Soc. phot. Belg.	Bulletin de la Société photographique de Belgique
Bull. Soc. Romane Stiin.	Buletinul societatii Romane de Stiinta
Bull. Soc. roy. pharm.	Bulletin de la société de pharmacie de Bruxelles royale
Bull. Soc. sci. med. Rennes	Bulletin de la société scientifique et médicale de l'ouest, Rennes

LIST OF ABBREVIATIONS TO LITERATURE.

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Bull. Soc. vaudoise	Bulletin de la Société vaudoise des Ingenieurs et des Architectes
Bull. Torrey Bot. Club	Bulletin of the Torrey Botanical Club, New York
Bull. Vulc. Ital.	Bullettino del Vulcanismo Italiano (e di Geodinamica generale)
C. A.	Chemical Abstracts
Cabanis, J. Ornithol.	Journal für Ornithologie
Cádiz, Period. Mens. Cien.	Periodico mensual de Ciencias matematicas y físicas
Caen, Acad. Mem.	Memoires de l'Academie des Sciences, Belles Lettres, et Arts de Caen
Caen, Bull. Soc. Linn. Normandie	Bulletin de la Société Linneenne de Normandie
Caen, Mem. Soc. Linn. Normandie	Memoires de la Société Linneenne de Normandie
Caen, Travaux	Precis des Travaux de la Société d'Agriculture, &c. de Caen
Calcutta, J. Natur. Hist.	The Calcutta Journal of Natural History
Calcutta, Quart. J.	Quarterly Journal of the Medico-Physical Society
Calcutta Roy. Bot. Gard. Ann.	Annals of the Royal Botanic Garden, Calcutta
Calcutta, Trans. Med. Phys. Soc.	Transactions of the Medical and Physical Society of Calcutta
Cal. Acad. Bull.	Bulletin of the California Academy of Sciences
Cal. Acad. Mem.	Memoirs of the California Academy of Sciences
Cal. Acad. Natur. Sci. Proc.	Proceedings of the Californian Academy of Natural Sciences
Cal. Acad. Pap.	Occasional Papers of the California Academy of Sciences
Cal. Min. Bur. Bull.	California State Mining Bureau. Bulletin
Cal. Min. Bur. Rep.	(California State Mining Bureau. Report of the State Mineralogist)
Calvados, Mem. Soc. Linn.	Memoires de la Société Linneenne du Calvados
Cambrai, Mem. Soc. Emul.	Memoires de la Société d'Emulation de Cambrai
Cambridge Mem. Analyt. Soc.	Memoirs of the Cambridge Analytical Society
Cambridge Mus. Comp. Zool. Bull.	Proceedings of the Museum of Comparative Zoology at Harvard College, Cambridge, Mass.
Cambr. Ornith. Club Bull.	Bulletin of the Nuttall Ornithological Club. A Quarterly Journal of Ornithology
Cambridge Phil. Soc. Proc.	Proceedings of the Cambridge Philosophical Society
Cambridge Phil. Soc. Trans.	Transactions of the Cambridge Philosophical Society
Cambridge, Studies Physiol. Labor	Studies from the Physiological Laboratory in the University of Cambridge
Camera Oscura	La Camera Oscura; rivista periodica universale dei progressi della Fotografia
Can.	Canadian—Canada
Can., Bot. Soc. Ann.	Annals of the Botanical Society of Canada
Can. Chem. J.	The Canadian Chemical Journal
Can. Drug.	Canadian Druggist
Can. Eng.	Canadian Engineer, The
Can. Entom.	The Canadian Entomologist
Can. Entom. Soc. Rep.	First Annual Report on the Noxious Insects of the Province of Ontario
Can. Inst. Proc.	Proceedings of the Canadian Institute (Toronto, being a continuation of "The Canadian Journal of Science, Literature and History")
Can. Inst. Trans.	Transactions of the Canadian Institute
Can. J.	The Canadian Journal of Industry, Science, and Art

Can. Naturalist	The Canadian Naturalist and Geologist, and Proceedings of the Natural History Society of Montreal
Can. P.	Canadian Patent
Can. Pat. Off. Rec.	Canadian Patent Office Record
Can. Pharm. J.	Canadian Pharmaceutical Journal and Pharmacal Gazette
Can. Rec. Sci.	The Canadian Record of Science, including the Proceedings of the Natural History Society of Montreal, and replacing the Canadian Naturalist
Can. Roy. Soc. Proc. Trans.	Proceedings and Transactions of the Royal Society of Canada
Canestrini	See Archivio Zool.
Canestrini, Archiv.	Archivio per la Zoologia, l'Anatomia, e la Fisiologia
Cannes Soc. Mem.	Memoires de la Société des Sciences Naturelles (et Historiques), des Lettres et des Beaux-Arts de Cannes, et de l'arrondissement de Grasse
Cantu, Cronaca	Cronaca
Caout. Gutta-p.	Caoutchouc et la Gutta-percha
Caradoc Field Club Trans.	Transactions of the Caradoc and Severn Valley Field Club
Cardiff Natur. Soc. Trans.	Cardiff Naturalists' Society. Report and Transactions
Carinthia	See Kärnten
Carl, Rep. Physik.	Repertorium für Experimental-Physik, etc. (Rep. der Physik)
Carlsberg Lab.	See under Kiøbenh.
Carlsruhe	See Karlsruhe
Carlsruhe, Verh. Naturwiss. Ver.	Verhandlungen des Naturwissenschaftlichen Vereins
Carloinisches Medico-Chirurgisches Institut.	See under Stockh. Physiol. Lab. Mitth.
Casus. Zool. Anzeiger	Zoologischer Anzeiger
Casopsis	Casopsis pro Pestovani Matematiky a Fysiky (Journal for the Advancement of Mathematics and Physics)
Casopsis Cesketho Lekarn.	Casopsis Cesketho Lekarnitura
Casper Vierteljahrssch.	Vierteljahrsschrift für gerichtliche und öffentliche Medicin
Casper's Wochensch.	Wochenschrift für die gesammte Heilkunde
Cassel Jahr.	Jahresbericht, dann Bericht, über die Thatigkeit des Vereins für Naturkunde in Cassel
Cassier's Mag.	Cassiers's Magazine
Castings	Castings
Catania Atti Accad. Gioen.	Atti dell'Accademia Gioenia di Scienze Naturali di Catania
Catania Boll. Accad. Gioen.	Bollettino delle Sedute della Accademia Gioenia
Cattaneo Bibl. di Farm.	Biblioteca di Farmacia, Chimica, etc.
Cattaneo Giorn. Farm.	Giornale di Farmacia
Cell. Ind.	Die Celluloid Industrie
Cellule	La cellule
Cement	Cement
Cement Age	Cement Age
Cement Eng. News	Cement and Engineering News
Cement Record	Cement Record
Centr. Agrik. Chem.	Central-Blatt für Agrikulturchemie und rationellen Wirthschafts-Betrieb. Referirendes Organ für naturwissenschaftliche Forschungen in ihrer Anwendung auf die Landwirtschaft
Centr. Allg. Path.	Centralblatt für allgemeine Pathologie

Centr. Bakt.	Centralblatt für Bacteriologie und Parasitenkunde
Centr. Med. Wiss.	Centralblatt für die medicinischen Wissenschaften
Centr. Mineral.	Centralblatt für Mineralogie, Geologie und Palaeontologie
Centr. Papierfabr.	Centralblatt für Papierfabrikation
Centr. Path.	Centralblatt für Allgemeine Pathologie und Pathologische Anatomie
Centr. Physiol.	Centralblatt für Physiologie
Centr. Text. Ind.	Centralblatt für die Textil-Industrie
Centr. Zuckerind.	Centralblatt für die Zuckerindustrie
Centrztg. Optik	Central-Zeitung für Optik und Mechanik (Elektrotechnik und verwandte Berufszweige)
Ceramique	Ceramique, La
Cette Stat. Maritime	See Montpellier Inst. Zool. Trar.
Ceyl. P.	Ceylon Patent
Chamb. Comm. J.	Chamber of Commerce Journal
Chambéry Mem. Acad. Savoie.	Memoires de la Societe Academique de Savoie.
Charente-Inf. Soc. Sci. Ann.	Academie de la Rochelle Societe des Sciences Naturelles de la Charente-Inferieure, Annales
Charkoff.	See Kharkov.
Charleston Med. Journ.	Charleston Medical Journal and Review
Charleston South J. Med.	The Southern Journal of Medicine
Chem. Age	Chemical Age
Chem. Centr.	Chemisches Centralblatt (1830-1906)
Chem. Coll. Reports	Reports of the Royal College of Chemistry, and Researches conducted in the Laboratories
Chem. Drug.	Chemist and Druggist, London
Chem. Drug. Australasia	Chemist and Druggist of Australasia
Chem. Eng.	Chemical Engineer
Chem. Gaz.	Chemical Gazette, The
Chem. Ind.	Chemische Industrie
Chem. Listy	Chemische Listy
Chem. News	Chemical News
Chem. Pharm. Centr. Blatt	Chemisch-pharmaceutisches Central Blatt
Chem. Rev.	The Chemical Review
Chem. Rev. Fett-Harz-Ind.	Chemische Revue über die Fett und Harz-Industrie
Chem. Tech. Mitth.	Elsner's Chemisch-Technische Mittheilungen
Chem. Tech. Rep.	Chemisch-Technisches Repertorium (Jacobsen 1862-1901)
Chem. Tech. Neuzeit	Chemische Technologie der Neuzeit
Chem. Tech. Übers.	Chemisch-Technische Übersicht (supplement to Chem. Ztg.)
Chem. Tech. Ztg.	Chemiker-und Techniker-Zeitung
Chem. Trade J.	Chemical Trade Journal and Chemical Engineer
Chem. Weekbl.	Chemisch Weekblad
Chem. World	Chemical World, The
Chem. Zentr.	Chemisches Zentralblatt (1907-)
Chem. Ztg.	Chemiker-Zeitung
Chem. Ztg. Rep.	Repertorium der Chemiker Zeitung
Chem. Zts.	Chemische Zeitschrift
Chemist	The Chemist
Chemnitz Ber.	Bericht der Naturwissenschaftlichen Gesellschaft zu Chemnitz
Cherbourg, Mem. Soc. Acad.	Memoires de la Société Academique de Cherbourg
Cherbourg, Mem. Soc. Sci.	Memoires de la Société Imperiale des Sciences Naturelles de Cherbourg

- Cherbourg Soc. Sci. Natl. Mem. Memoires de la Société Nationale des Sciences Naturelles et Mathématiques de Cherbourg
- Chéster Soc. Sci. Proc. Proceedings of the Chester Society of Natural Science (and Literature)
- Chicago Acad. Sci. Bull. Bulletin of the Chicago Academy of Sciences
- Chicago Acad. Sci. Bull. Nat. Hist. Surv. The Chicago Academy of Sciences. Bulletin... of the Natural History Survey
- Chicago Acad. Sci. Trans. Transactions of the Chicago Academy of Sciences
- Chicago Entom. Soc. Mem. Occasional Memoirs of the Chicago Entomological Society
- Chicago Field Columb. Mus. Publ. Publications of the Field Columbian Museum
- Chile, Anales Univ. Anales de la Universidad de Chile
- Chile P. Chilean Patent
- Chili Soc. Sci. Act. Actes de la Société Scientifique du Chili (Actas de la Sociedad Científica de Chile)
- Chim. et Ind. Chimie et Industrie
- Chimiste Chimiste, Le
- Christiania, Forh. Forhandlinger i Videnskabs-Selskabet i Christiania
- Christiania, Norsk Mag. Norsk Magazin for Laegevidenskaben
- Christiania Skr. (Math.-Nat. Kl.) Skrifter udgivne af Videnskabselskabet i Christiania. Matematisk-naturvidenskabelig Klasse
- Christiania, Univers. Lab. Das chemische Laboratorium der Universität Christiania
- Chron. ind. Chronique de l'industrie
- Chur, Jahresber. Naturf. Gesell. Jahresbericht der Naturforschenden Gesellschaft von Graubünden in Chur
- Ciment Ciment, Le
- Cincin. Soc. Natur. Hist. The Journal of the Cincinnati Society of Natural History
- Cistula Entom. Cistula Entomologica
- Civil Eng. Inst. Trans. Transactions of the Institution of Civil Engineers
- Civil Eng. J. The Civil Engineer and Architect's Journal, etc.
- Civilingenieur Der Civilingenieur
- Clay Worker Clay Worker, The
- Clermont, Mem. Acad. Sci. Memoires de l'Academie des Sciences, Belles Lettres, Arts de Clermont-Ferrand
- Cleveland Med. J. Cleveland Medical Journal
- Clin. Soc. Trans. Transactions of the Clinical Society of London
- Coblentz, Jähr. bot. Ver. Jahresbericht des botanischen Vereines am Mitten und Niederrheine, mit botanischen Abhandlungen
- Cohn, Beitr. Biol. Pflanz. Beiträge zur Biologie der Pflanzen
- Coimbra, Inst. O Instituto, journal scientifico et letterario
- Coimbra, Soc. Broter. Bol. Sociedade Broteriana. Boletim Anual
- Col. P. Colombian Patent
- Collegium Collegium (Scientific technical supplement to Ledermarkt)
- Colliery Guardian Colliery Guardian and Journal of the Iron and Coal Trades
- Colmar Soc. Hist. Natur. Bull. Bulletin de la Société d'Histoire Naturelle de Colmar
- Colombia, Contrib. Contribuciones de Colombia a las Ciencias i a las Artes
- Colombo See Ceylon
- Colorado Sci. Soc. Proc. Proceedings of the Colorado Scientific Society
- Comment. Fauna &c. Ven. Commentario della Fauna, Flora e Gea del Veneto e Trentino
- Compt. rend Comptes rendus hebdomadaires des Seances de l'Academie des Sciences

Compt. rend. Assoc. Franc.	Association Francaise pour l'Avancement des Sciences.
Compt. rend. minerale	Compte Rendu de la 1 ^e (-12 ^e) Session; 1872-83
Compt. rend. Soc. biol.	Comptes rendus de la Société de l'industrie minerale
	Comptes rendus des seances et memoires de la Société de biologie, Paris
Compt. rend. trav. lab. Carlsberg	Comptes rendus du travaux du laboratoire de Carlsberg
Concrete	Concrete
Concrete Age	Concrete Age
Concrete Constr. Eng.	Concrete and Constructional Engineering
Concrete Eng.	Concrete Engineering (no longer published separately. Combined with Cement Age)
Conegliano Scuola Vit. Enol. Ann.	Annali della R. Scuola di Viticoltura e di Enologia in Conegliano
Conegliano Scuola Vit. Enol. N. Rassegna	Nuova Rassegna di Viticoltura e di Enologia della R. Scuola di Conegliano
Conegliano Scuola Vit. Enol. Riv.	La Rivista. Periodico (quindicinale, Organo) della R. Scuola di Viticoltura e di Enologia (e del Comizio Agrario) di Conegliano
Cong. P.	Congo Free State Patent
Congr. Anthropol. Compt. Rend.	Congres international d'Anthropologie et d'Archeologie prehistoriques. Comptes Rendus
Congr. Bot. Crittog. Atti	Societa Crittogamologica Italiana. Atti del Congresso Nazionale di Botanica Crittogama in Parma
Congr. Bot. Int. Atti	Atti del Congresso Internazionale di Genova
Congr. Int. Bot. Bull.	Bulletin du Congres International de Botanique et d'Horticulture reuni a St. Petersburg...
Congr. Internatl. Hortic. Bull.	Bulletin du Congres International d'Horticulture a Bruxelles
Congr. Internatl. Med. Atti	Atti dell' XI. Congresso Medico Internazionale
Congr. Internatl. Med. C. R.	Comptes-Rendus du XII Congres International de Medecine
Congr. Internatl. Sci. Med. C. R.	Congres Periodique International des Sciences Medicales. Compte-Rendu
Congr. Internatl. Zool. (C. R.)	Congres International de Zoologie
Connecticut, Acad. Mem.	Memoirs of the Connecticut Academy of Arts and Sciences
Connecticut Acad. Trans.	Transactions of the Connecticut Academy of Arts and Sciences
Contrib. Biol. Veg.	Contribuzioni alla Biologia Vegetale
Copenhagen	See Kjobenhavn.
Copenhagen	See Congr. Int. Sci. Med. C. R., 1884
Copenhagen, Résumé	Résumé du Bulletin de la Société Royale Danoise des Sciences
Cordoba, Acad. Bol.	Boletin de la Academia Nacional de Ciencias Exactas existente en la Universidad de Cordoba
Cordoba Acad. Ci. Act.	Actas de la Academia Nacional de Ciencias en Cordoba
Corn Trade J.	Corn Trade Journal
Cornwall, J. Roy. Inst.	Journal of the Royal Institution of Cornwall
Cornwall Poly. Soc. Rep.	Royal Cornwall Polytechnic Society, Annual Report
Cornwall, Poly. Soc. Trans.	Reports and Transactions of the Royal Geological Society of Cornwall
Corresp. Blatt. Schweiz. Aerzte	Correspondenz-Blatt für Schweizer Aerzte
Corresp. Blatt Zahn.	Correspondenzblatt für Zahnärzte
Cosmos	Cosmos: Revue Encyclopedique hebdomadaire

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Costa, Corresp. Zool.	Corrispondenza Zoologica, destinata a diffondere nel regno delle Due Sicilie tutto cio che si va discuo- piendo entro e fuori Europa (e vice-versa), rfa guardante la Zoologia in generale
Cotteswold Club Proc.	Proceedings of the Cotteswold Naturalists' Field Club
Cracovie Acad. Sci. Bull	Bulletin International de l'Academie des Sciences de Cracovie
Cracow	See Krakow
Crell. Ann	Chemische Annalen fur die Freunde der Naturlehre, etc
Crichton, Russ. Sammlung	Russische Sammlung fur Naturwissenschaft und Heilkunst
Cron. med. mex.	Cronica medica mexicana, Mexico
Croydon Micro Club Proc.	Proceedings and Transactions of the Croydon Micro- scopical and Natural History Club
Croydon Micro. Club Rep	Report and Abstract of Proceedings of the Croydon Microscopical (and Natural History) Club
Cuba P.	Cuban Patent
Cuba, Rep. Fis. Nat.	Repertorio fisico-naturale de la isla de Cuba
Cuir	Cuir, Le
Cumberland Assoc. Trans	Transactions of the Cumberland and Westmorland Association for the Advancement of Literature and Science
Cuyper, Rev. Univ.	Revue Universelle des Mines, de la Metallurgie, &c.
D'Alton u. Burm. Ztg Zool.	Zeitung fur Zoologie, Zootomie, und Palaeozoologie
Dan. Biol. Stat. Rep.	Report of the Danish Biological Station to the Home Department (Board of Agriculture)
Dan P.	Danish Patent
Danzig, Neu. Schrift.	Neueste Schriften der Naturforschenden Gesellschaft in Danzig
Danzig, Schrift.	Schriften der Naturforschenden Gesellschaft in Danzig
Darmst. Beitr. Geol.	Beiträge zur Geologie des Grossherzogthums Hessen und der angrenzenden Gegenden
Darmst. Ver. Erdk. Notiz	Notizblatt des Vereins fur Erdkunde zu Darmstadt und des Mittelrheinischen Geologischen Vereins
Davenport Acad. Proc	Proceedings of the Davenport Academy of Natural Sciences
Dax Soc. Borda Bull	(Bulletin de la) Société de Borda, Dax (Landes)
Delft Ecole Poly. Ann.	Annales de l'Ecole Polytechnique de Delft
Delhi, Med. J.	Quarterly Medical and Surgical Journal for the North- West Provinces
Denison Univ. Sci. Lab. Bull.	Bulletin of (the Scientific Laboratories of) Denison University
Dent. Cosmos	Dental Cosmos, Philadelphia
Dent. Digest	The Dental Digest, Chicago
Dent. Rev.	The Dental Review
Dent. Amer. Apoth. Ztg.	Deutsch-Amerikanische Apotheker Zeitung, New York
Dent. Amer. Gewerbeztg.	Illustrierte Deutsch-Amerikanische Gewerbe und In- dustrie-Zeitung (Newark, N. J.)
Deut. Arch. Klin. Med.	Deutsches Archiv. fur Klinische Medizin
Deut. Bot. Ges.-Ber.	Berichte der Deutschen Botanischen Gesellschaft
Deut. Bot. Monats.	Deutsche Botanische Monatsschrift
Deut. Buchdr. Ztg.	Deutsche Buchdrucker-Zeitung
Deut. Eisenbahn Ztg	Zeitung des Vereins Deutscher Eisenbahn-Verwalt- ungen
Deut. Elektro. Ges.	See Zts. Elektroch.

Deut. Entom. Zts.	Deutsche Entomologische Zeitschrift (formerly <i>Berliner Entomologische Zeitschrift</i>)
Deut. Geol. Ges. Zts.	Zeitschrift der Deutschen Geologischen Gesellschaft
Deut. Gerber Ztg.	Deutsche Gerber Zeitung
Deut. Ind. Ztg.	Deutsche Industrie Zeitung
Deut. Klinik	Deutsche Klinik
Deut. Mechan. Ztg.	Deutsche Mechaniker-Zeitung
Deut. med. Wochenschr.	Deutsche medizinische Wochenschrift
Deut. Monats.	Deutsche Monatshefte
Deut. Naturf. Ber.	Ämtlicher Bericht der . Versammlung Deutscher Naturforscher und Aerzte
Deut. Naturf. Festschr.	Festschrift für die 59. Versammlung Deutscher Naturforscher und Aerzte
Deut. Naturf. Tagebl.	Tageblatt der. Versammlung Deutscher Naturforscher und Aerzte
Deut. Naturf. Versamml. Ber.	Bericht über die Versammlung der Deutschen Naturforscher und Aerzte
Deut. Poly. Ztg.	Allgemeine Deutsche Polytechnische Zeitung (H. Grothe)
Deut. Phys. Ges. Verh.	Verhandlungen der Deutschen Physikalischen Gesellschaft
Deut. Tech. Ztg.	Deutsche Techniker Zeitung
Deut. Topfer Ziegl. Ztg.	Deutsche Topfer und Ziegler Zeitung
Deut. Vierteljahrsschr. Oeff. Gesundh.	Deutsche Vierteljahrsschrift für Gesundheitspflege
Deut. Zool. Ges.	See Zool. Anz.
Deut. Zool. Ges. Verh.	Verhandlungen der Deutschen Zoologischen Gesellschaft
Deut. Zts. Chirurg.	Deutsche Zeitschrift für Chirurgie
Deut. Zts. Thiermed.	Deutsche Zeitschrift für Thiermedizin und vergleichende Pathologie
Deut. Zuckerind.	Deutsche Zuckerindustrie
Devon Assoc. Trans.	Transactions of the Devonshire Association for the Advancement of Science, Literature and Art
Devon & Cornwall Natur. Hist. Soc.	See Plymouth Inst. Trans.
Diamant Ztg.	Diamant, Glas-Industrie Zeitung
Dietet. Hyg. Gaz.	Dietetic and Hygiene Gazette, The
Dijon, Acad. Sci. Mem.	Memoires de l'Academie des Sciences, Arts et Belles-Lettres de Dijon
Dijon, J. Agric.	Journal d'Agriculture de la Cote d'Or
Dijon, Seances Acad.	Seances publiques de l'Academie des Sciences, Arts, et Belles-Lettres de Dijon
Dinant, Soc. Natur. Bull.	Bulletin de la Société des Naturalistes Dinantais
Dingl. Poly.	Dinglers Polytechnisches Journal
Donders, Archiv.	Archiv für die Hollandischen Beyträge zur Natur- und Heilkunde
Dorpat, Archiv.	Archiv für die Naturkunde Liv-, Esth-, und Kurlands
Dorpat, Biol. Naturk.	Biologische Naturkind.
Dorpat, Naturf. Ges.	See Arch. Nat. (Dorpat)
Dorpat, Naturwiss. Abh.	Naturwissenschaftliche Abhandlungen aus Dorpat
Dorpat Pharm. Inst. Arb.	Arbeiten des Pharmakologischen Institutes zu Dorpat
Dorpat Sitzber.	Sitzungsberichte der Naturforscher-Gesellschaft bei der Universität (Jurjew) Dorpat
Dorpat Schr.	Schriften herausgegeben von der Naturforschenden Gesellschaft bei der Universität (Jurjew) Dorpat
Dorset Field Club Proc.	Proceedings of the Dorset Natural History and Antiquarian Field Club

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Douai Mem. Soc. Agric.	Memoires de la Société d'Agriculture, de Sciences, et d'Arts, seant a Douai
Doubs Soc. Emul. Mem.	Memoires de la Société d'Emulation du Departement du Doubs
Dove Rep. Physik.	Repertorium der Physik. Enthaltend eine Vollständige Zusammenstellung der neuern Fortschritte dieser Wissenschaft
Dresden Ausz. Protokol.	Auszüge aus den Protokollen der Gesellschaft für Natur- und Heilkunde in Dresden
Dresden Denkschr. Naturwiss. Ges. Isis.	Denkschriften der Naturwissenschaftlichen Gesellschaft Isis zu Dresden
Dresden Entom. Ver. "Iris" Corresp.-Bl.	See Iris
Dresden Isis Festschr.	Festschrift der Naturwissenschaftlichen Gesellschaft Isis in Dresden
Dresden Isis Sitzber.	Sitzungsberichte und Abhandlungen der Naturwissenschaftlichen Gesellschaft Isis in Dresden
Dresden, Jahr. Natur. Heilk.	Jahresberichte für 1858-60 v. d. Gesellschaft für Natur- und Heilkunde in Dresden
Dresden, Mitth. Poly. Schule	Mittheilungen der K. Sächs. Polytechnischen Schule
Dresden, Schr. Ges. Mineral.	Auswahl aus den Schriften der unter Werner's Mitwirkung gestifteten Gesellschaft für Mineralogie
Dresden, Sitzber. Natur. Heilk.	Sitzungsberichte der Gesellschaft für Natur- und Heilkunde
D. R. P.	German Patent (Deutsches Reichs-Patent)
Drug. Circ.	Druggist's Circular
Drug Topics	Drug Topics, New York
Dublin, Geol. Soc. J.	Journal of the Geological Society of Dublin
Dublin, Hosp. Gaz.	Dublin Hospital Gazette
Dublin J. Med. Chem. Sci.	Dublin Journal of Medical and Chemical Science
Dublin J. Med. Sci.	The Dublin Journal of Medical Science
Dublin Med. Trans.	Dublin Medical Transactions
Dublin Micro. Club	See Irish Natur.
Dublin, Natur. Hist. Soc. Proc.	Proceedings of the Natural History Society of Dublin
Dublin Natur. Field Club	See Irish Natur.
Dublin, Pathol. Soc. Proc.	Proceedings of the Pathological Society of Dublin
Dublin Quart. J.	The Dublin Quarterly Journal of Science
Dublin Quart. J. Med.	Dublin Quarterly Journal of Medical Science
Dublin, Roy. Soc. J.	Journal of the Royal Dublin Society
Dublin Soc. J., Dublin Soc. Trans.	Transactions and Journal of the Dublin Society
Dublin Soc. Sci. Proc.	The Scientific Proceedings of the Royal Dublin Society
Dublin Soc. Sci. Trans.	The Scientific Transactions of the Royal Dublin Society
Dublin, Zool. Bot. Assoc. Proc.	Proceedings of the Dublin University Zoological and Botanical Association
Dudley, Geol. Soc. Proc.	Transactions of the Dudley and Midland Geological and Scientific Society
Dumfr. Gallow. Soc. Trans.	The Transactions and Journal of Proceedings of the Dumfriesshire and Galloway Natural History and Antiquarian Society
Dunkerque, Mem. Soc. Encour.	Memoires de la Société Dunkerquoise pour l'Encouragement des Sciences, des Lettres, et des Arts
Durham Univ. Phil. Soc. Proc.	Proceedings of the University of Durham Philosophical Society

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Dyer, Calico Ptr.	Dyer, Calico Printer, Bleacher, Finisher, and Textile Review
Dzondi, Aeskulap	Aeskulap
Eastbourne Natur. Hist. Soc. Papers (& Trans.)	Papers (Transactions) of the Eastbourne Natural History Society
Eastbourne Natur. Hist. Soc. Proc.	The Sixth Annual Report of the Eastbourne Natural History Society
Eastbourne Natur. Hist. Soc. Trans.	Transactions of the Eastbourne Natural History Society
Echange	l'Echange. Organe (Mensuel) des Naturalistes de la Region Lyonnaise
Eckhard, Beitr.	Beiträge zur Anatomie und Physiologie
Eclairage Elect.	l'Eclairage Electrique. Revue Hebdomadaire d'Electricite
Eclect. Med. J., Cincin.	Eclectic Medical Journal, Cincinnati
Econ. Geol.	Economic Geology
Ecu. P.	Ecuador Patent
Edinb. Bot. Soc. Proc.	Proceedings of the Botanical Society of Edinburgh for the years 1855-56
Edinb. Bot. Soc. Trans.	Transactions of the Botanical Society of Edinburgh
Edinb. Field Club Trans.	Transactions of the Edinburgh Naturalists' Field Club
Edinb., Fish Bd. Rep.	Annual Report of the Fishery Board for Scotland
Edinb. J. Med Sci	Edinburgh Journal of Medical Science
Edinb. J. Natur. Geogr. Sci.	The Edinburgh Journal of Natural and Geographical Science
Edinb. J. Sci.	The Edinburgh Journal of Science
Edinb. Med. Chir. Soc. Trans.	Transactions of the Medico-Chirurgical Society of Edinburgh
Edin. Med. J.	Edinburgh Medical Journal
Edinb. Mem. Wern. Soc.	Memoirs of the Wernerian Natural History Society
Edinb. Monthly J. Med. Sci.	Edinburgh Monthly Journal of Medical Science
Edinb. Natur. Soc. Trans.	Transactions of the Edinburgh Field Naturalists' and Microscopical Society, instituted as the Edinburgh Naturalists' Field Club
Edinb. N. Phil. J.	The Edinburgh New Philosophical Journal
Edinb. Phil. J.	The Edinburgh Philosophical Journal
Edinb. Plin. Soc. Trans.	Transactions of the Plinian Society
Edinb. Proc. Phys. Soc.	Proceedings of the Royal Physical Society of Edinburgh
Edinb. Roy. Coll. Physns. Lab. Rep.	Reports from the Laboratory of the Royal College of Physicians, Edinburgh
Edinb. Roy. Soc. Proc.	Proceedings of the Royal Society of Edinburgh
Edinb. Roy. Soc. Trans.	Transactions of the Royal Society of Edinburgh
Edinb. Trans. Scot. Soc. Arts	Transactions of the Royal Scottish Society of Arts
Eisen Ztg.	Eisen Zeitung
Ekaterinburg	See Iekaterinenb.
Elberfeld Naturwiss. Ver. Jahr.	Jahres-Bericht des Naturwissenschaftlichen Vereins in Elberfeld
Elec. Rev.	The Electrical Review
Elec. Soc. Trans.	The Transactions and Proceedings of the London Electrical Society
Elec. Telegr. Rev.	The Electric Telegraph Review
Elec. World	Electrical World
Electrician	The Electrician
Electricite	l'Electricite
Electrochem. Met. Ind.	Electrochemical and Metallurgical Industry

Elektrochem Zts	Elektrochemische Zeitschrift
Elektrotech Zts.	Electrotechnische Zeitschrift
Elliott Soc. J.	Journal of the Elliott Society of Natural History
Elliott Soc. Proc.	Proceedings of the Elliott Society of Natural History
Elsner, Mitth.	See Chem. Tech. Mitth.
Emden Naturf. Ges. Jahr.	Jahresbericht der Naturforschenden Gesellschaft in Emden
Emden Naturf. Ges. Schr.	Kleine Schriften der Naturforschenden Gesellschaft in Emden
Eng.	Engineering
Eng. Contr.	Engineering and Contracting
Eng. Digest	Engineering Digest
Eng. Mag.	Engineering Magazine, The
Eng. Mining J. (Eng. Min. J.)	Engineering and Mining Journal, The
Eng. News	Engineering News
Eng. Record	Engineering Record, Building Record and Sanitary Engineer
Engineer	Engineer, The
Engineers' J.	The Engineers' Journal and Railway Gazette of India and the Colonies
Engineers Soc. Trans.	Society of Engineers. Transactions
Engl. Mech.	English Mechanic
Engler, Bot. Jahr.	Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie
Engrais, L'	Engrais, L'
Entom. Annual	The Entomologist's Annual
Entom. Mag.	The Entomological Magazine
Entom. Medd (Kjöbenh.)	Entomologiske Meddelelser udgivne af Entomologisk Forening
Entom. Month Mag.	The Entomologist's Monthly Magazine
Entom. Nachr.	Entomologische Nachrichten
Entom. Record	The Entomologist's Record and Journal of Variation
Entom. Soc. Trans.	The Transactions of the Entomological Society of London
Entom. Tidskr.	Entomologisk Tidskrift på Föranstaltande af Entomologiska Föreningen i Stockholm
Entomologica Amer.	Entomologica Americana
Entomologist	The Entomologist
E. P.	English (British) Patent
Epicure	Epicure, The
Epidem. Soc. Trans.	Transactions of the Epidemiological Society of London
Epinal (Vosges) Ann.	Annales de la Société d'Émulation du département des Vosges
Erdel. Muz.-Egyl. Ért.k.	Az Erdelyi Múzeum-Egylet Kiadványai Értekezések. (Publications of the Transylvanian Museum Association. Memoirs)
Erdmann, Sveriges Geol. Undersök.	Sveriges geologiska Undersökning, på offentlig bekostnad, utförd under Ledning af A. Erdmann
Erfurt, Abh. Akad. Wiss.	Abhandlungen der Kurfürstlich Mainzer Akademie nützlicher Wissenschaften zu Erfurt
Erfurt, Akad. Jahr.	Jahrbücher der königlichen Akademie gemeinnütziger Wissenschaften zu Erfurt
Erfurt, Denkschr.	Denkschrift der Akademie gemeinnütziger Wissenschaften in Erfurt
Erfurt, Nova Acta	Nova Acta Academiae Electoralis Moguntinae Scientiarum utilium quae Erfurti est.

Ergeb. Physiol.	Ergebnisse der Physiologie, Wiesbaden
Erlangen, Abh.	Abhandlungen der Physikalisch-medizinischen Societät in Erlangen
Erlangen Anat. Inst.	See Bietr Morphol
Erlangen, Mitth. Phys. Med. Soc.	Wissenschaftliche Mittheilungen der Physikalisch-medizinischen Societät zu Erlangen
Erlangen Phys. Med. Soc. Sitzber.	Sitzungsberichte der Physikalisch-Medizinischen Societät zu (in) Erlangen
Erythæa	Erythæa A Journal of Botany, West American and General
Essex Field Club Proc.	Journal of Proceedings of the Essex Field Club
Essex Field Club Spec. Mem.	Essex Field Club Special Memoirs
Essex Field Club Trans	Transactions of the Essex Field Club
Essex Inst. Bull.	Bulletin of the Essex Institute
Essex Inst. Commun.	Communications read before the Essex Institute
Essex Inst. Proc.	Proceedings of the Essex Institute
Essex Natur. Hist. Soc. J.	Journal of the Essex County Natural History Society
Essex Natlist.	The Essex Naturalist
Essig. Ind.	Deutsche Essigindustrie
Études Gîtes Mineraux	See France Gîtes Min. Études
Eure, Bull. Acad. Ebrouic.	Bulletin de l'Académie Ebrouicenne
Eure, J. Agric.	Journal d'Agriculture, de Médecine et des Sciences accessoires
Eure, Recueil Trav.	Recueil des Travaux de la Société Libre d'Agriculture, des Sciences, des Arts et des Belles Lettres du département de l'Eure
Eure, Soc. Agric. Bull.	Bulletin de la Société d'Agriculture, des Sciences, et des Arts du département de l'Eure
Eure, Soc. Agric. Recueil	Recueil de la Société d'Agriculture, Sciences, Arts, et Belles-Lettres du département de l'Eure
Eykonyv	A' Magyar Tudos Tarsasag' Eykonyvi
Exner. Rep.	Repertorium der Physik
Exper. Sta. Rec.	Experiment Station Record
Eyr.	Eyr, et Medicinsk Tidsskrift
Fachgenosse	Fachgenosse, Der
Falaise, Mem. Soc. Acad.	Mémoires de la Société Académique des Sciences, &c, de Falaise
Farben Ztg.	Farben Zeitung
Farb. Ztg.	Farber Zeitung (Lehne's)
Fechner Centr.	Centrallblatt für Naturwissenschaften und Anthropologie
Fechner, Rep.	Repertorium der Experimental-Physik.
Fed. Inst. Min. Engin. Trans.	Transactions of the Federated Institution of Mining Engineers
Fer.	Ferrum, Halle
Ferussac, Bull. Sci. Math.	Bulletin des Sciences Mathématiques, Astronomiques, Physiques, et Chimiques par le Baron de Ferussac
Ferussac, Bull. Sci. Natur.	Bulletin des Sciences Naturelles et de Géologie
Feuille Jeunes Natur.	Feuille des Jeunes Naturalistes
Field Mus. Natur. Hist.	Field Museum of Natural History, Chicago, Publication
Fiji. P.	Fiji Islands Patent
Fin. P.	Finland Patent
Finistere Soc. Sci. Bull.	Bulletin de la Société d'Études Scientifiques du Finistere
Finlande Soc. Geogr.	See Fennia
Finska Lak. Sällsk. Handl.	Finska Lakare Sällskapets handlingar
Finska Vet. Soc.	See Helsingfors, Bidrag Helsingfors, Öfvers

Firenze Accad. Georgofili	Atti della Reale Accademia Economico-Agraria dei Georgofili di Firenze
Atti	
Firenze, Ann. Mus. Fis.	Annali del R. Museo di Fisica e Storia Naturale
Firenze, Ann. Mus. Imp.	Annali del Museo Imperiale di Fisica e Storia Naturale di Firenze
Firenze Congr. Bot. Atti	Atti del Congresso Internazionale Botanico tenuto in Firenze nel mese di Maggio 1874
Firenze, Mem. Soc. Ital.	See Modena
Firenze, Opusc. Sci.	Collezione d'Opuscoli scientifici.
Firenze R. Ins. ^{te} . Pubbl.	Pubblicazioni del R. Istituto di Studi Superiori Pratici e di Perfezionamento in Firenze
Firenze Soc. Georgofili Atti	Atti della (Real) Società Economica di Firenze ossia de' Georgofili
Firenze Soc. Studi Geogr.	See Riv. Geogr. Ital.
Boll.	
Flora	Flora oder Allgemeine Botanische Zeitung
Flore Jardins	Annales d'Horticulture et de Botanique, ou Flore des Jardins du Royaume des Pays-Bas
Flore Serres	Flore des Serres et des Jardins de l'Europe
Florence	See Firenze
Flörke, Repertr.	Repertorium des neuesten und wissenwürdigsten aus der gesammten Naturkunde
Földt. Közlön	Földtani Közlöny, Havi folyóirat kiadja a Magyarhoni Földtani Társulat
Folia Clin	Folia clinica chimico et microscopica
Folia haematol.	Folia haematologica
Folia Therap. Lond.	Folia Therapeutica, London
Forbes, Med. Rev.	The British and Foreign Medical Review, or Quarterly Journal of Practical Medicine and Surgery
Forsch. Agr.-Phys.	Forschungen auf dem Gebiete der Agrikultur-Physik.
Förster, Allg. Bauztg	Allgemeine Bauzeitung
Fortschr. Chem.	Fortschritte der Chemie, Physik und Physikalischen chemie
Fortschr. Med.	Fortschritte der Medicin.
Fortschr. Phys.	Die Fortschritte der Physik.
Fortschr. Röntgenstr.	Fortschritte auf dem Gebiete der Röntgenstrahlen
Fortschr. Theerfarben-	Fortschritte der Theerfarbenfabrikation und ver-
Fabrikation	wendter Industriezweige
Foundry	Foundry, The
F. P.	French Patent
France, Congr. Med. Chir.	Congres Medico-Chirurgical de France
France, Congr. Sci.	Sessions des Congres Scientifiques de France
France Gites Miner. Études	Études des Gites Minéraux de la France
France, Inst. Provinces	Annuaire de l'Institut des Provinces et des Congres
Annuaire	Scientifiques de France
France, Inst. Provinces	Memoires de l'Institut des Provinces de France:
Mem.	Sciences physiques et naturelles
France Soc. Agric. Bull.	Bulletin des Seances de la Société Nationale d'Agriculture de France
France Soc. Agric. Mem.	Memoires publiés par la Société Nationale d'Agriculture de France
France Soc. Bot. Bull.	Bulletin de la Société Botanique de France
France Soc. Entom.	See Abeille., Paris, Soc. Ent. Ann., Paris, Soc. Ent. Bull., Rev. Ent.
Franc Soc. Miner. Bull.	Bulletin de la Société Mineralogique de France.
	Bulletin de la Société Française de Mineralogie. (Ancienne Société Mineralogique de France)
France Soc. Zool.	See Paris, Caus. Sci.
France Soc. Zool. Bull.	Bulletin de la Société Zoologique de France

France Soc. Zool. Mem.	Memoires de la Société Zoologique de France
Frankfurt	See Senckenberg
Frankfurt, Jahr. Phys. Ver.	Jahrbuch zur Verbreitung naturwissenschaftlicher Kenntnisse, veranstaltet vom Physikalischen Verein zu Frankfurt a/Main
Frankf. Ver. Pflege Phot.	See Wien, Photogr. Correspond
Frankfurt, Zool. Garten	Der Zoologische Garten Frankfurt a/M.
Frankfurter Zts. Pathol.	Frankfurter Zeitschrift für Pathologie
Französ. Ann.	Französische Annalen für die allgemeine Naturgeschichte, Physik, &c.
Freiberg, Jahr. Berg. Hutt.	Jahrbuch für den Berg- und Hüttenmann. Herausg. von der Königl. Berg-Akademie zu Freiberg
Freiburg, Beitr.	Beiträge zur Rheinischen Naturgeschichte
Freiburg, Ber.	Berichte über die Verhandlungen der Naturforschenden Gesellschaft zu Freiburg i. B.
Freie K.	Freie Künste
Frelon	Le Frelon. Journal d'Entomologie descriptive
Fries, Bot. Notiser	Botaniska Notiser
Froriep, Notizen	Notizen aus dem Gebiete der Natur- und Heilkunde
Fühlings's Ztg.	Fühlings landwirtschaftliche Zeitung
Gac. ind.	La Gaceta industrial
Gand, Ann. Soc. Agric.	Annales de la Société Royale d'Agriculture et de Botanique
Gand, Ann. Soc. Med.	Annales de la Société de Médecine de Gand
Gand, Bull. Soc. Med.	Bulletin de la Société de Médecine de Gand
Gard, Aperçu Trav.	Notice ou Aperçu analytique des Travaux de l'Académie Royale du Gard
Gard, Mem. Acad.	Memoires de l'Académie du Gard
Gard, Notice Trav. Acad.	Notice des Travaux de l'Académie du Gard
Garden & Forest	Garden and Forest. A Journal of Horticulture, Landscape Art and Forestry
Gardeners Chron.	The Gardeners Chronicle
Garnett, Ann. Phil.	Annals of Philosophy, Natural History, Chemistry &c.
Garten-Flora	Garten-Flora
Garten-Ztg.	Neue allgemeine Deutsche Garten- und Blumenzeitung
Gartenwelt	Gartenwelt, The
Gas World	Gas World, The
Gaz	Le Gaz
Gazz. del. Clin.	Gazzetta della Cliniche
Gazz. med. ital lomb.	Gazzetta medica italiana lombardia, Milano
Gazz. Chim. Ital.	Gazzetta Chimica Italiana
Geelong Field Natur. Club	See Wombat
Gehlen J.	Journal für die Chemie und Physik
Gendrin, Trans. Med.	Transactions Médicales
Geneeskundig Mag.	Geneeskundig Magazijn
Geneve, Archiv.	See Archives Sci. Phys. Nat.
Geneve, Bull. Soc. Ornith. Suisse.	Bulletin de la Société Ornithologique Suisse
Geneve Conserv. Bot. Annuaire	Annuaire du Conservatoire du Jardin Botanique de Geneve
Geneve, Inst. Natl. Bull.	Bulletin de l'Institut National Genevois
Geneve, Inst. Natl. Mem.	Memoires de l'Institut National Genevois
Geneve, Mus. Hist. Natur. Ann.	See Rev. Suisse Zool.
Geneve, Recueil Trav. Soc. Med.	Recueil des Travaux de la Société Médicale de Geneve
Geneve, Soc. Geogr. Mem.	Memoires de la Société de Géographie de Geneve

- Geneve, Soc. Phys. Mem. Memoires de la Société de Physique et d'Histoire Naturelle de Geneve
 Genie civ. Genie Civil
 Genova See Congr. Bot. Int. Atti. 1892
 Genova, Ann. Mus. Phys. Annali del Museo Civico di Storia Naturale
 Genova, Giorn. Giornale degli Studiosi di Lettere, Science, arti e Mestieri
 Genova, Mem. Accad. Memoire dell'Accademia Imperiale delle Scienze di Genova
 Genova, Mem. Is. Ligure. Memorie dell' Istituto Ligure
 Genova, Mem. Soc. Med. Emul. Memorie della Societa Medica di Emulazione di Genova
 Genova Mus. Civ. Ann. Annali del Museo Civico di Storia Naturale di Genova
 Genova Mus. Zool. Anat. Bollettino dei Musei di Zoologia e Anatomia Comparata della R. Università di Genova
 Genova, Soc. Ligust. Atti Atti della Società Ligustica di Scienze Naturali e Geografiche
 Genova Univ. Atti Atti della R. Università di Genova
 Geogr. Soc. J. Journal of the Royal Geographical Society of London
 Geogr. Soc. Proc. Proceedings of the Royal Geographical Society and Monthly Record of Geography
 Geogr. Soc. Suppl. Pap. Royal Geographical Society. Supplementary Papers
 Geol. Mag. Geological Magazine
 Geol. Survey, Can. Geological Survey, Canada
 Gera, Naturwiss. Jahr. Jahresbericht der Gesellschaft von Freunden der Naturwissenschaften in Gera, nebst Nachrichten über den Naturwissenschaftlichen Verein in Schleiz
 Der Gerber
 Germar, Mag. Entom. Magazin der Entomologie
 Germar, Zts. Entom. Zeitschrift für die Entomologie
 Gergonne, Ann. MATH. Annales de Mathématique
 Gesundh. Ing. Gesundheits-Ingenieur
 Gew. Ztg. Wieck's Gewerbezeitung
 Gewerbebl. Schw. Schweizerisches Gewerbeblatt
 Gewerbebl. Würt. Gewerbeblatt aus Württemberg
 Gewerbeh. Gewerbehalle
 Gewerks Ztg. Oesterreichische Gewerkszeitung
 Giessen, Oberhess. Ges. Ber. Berichte der Oberhessischen Gesellschaft für Natur- und Heilkunde
 Giesel, Zts. See Zts. Gesamt. Naturwiss.
 Gilbert, Ann. Phys. See Ann. Phys.
 Gill, Tech. Micro. Repos. Technical and Microscopical Repository
 Giorn. Arcad. Giornale Arcadico di Scienze
 Giorn. farm. chim. Giornale de farmacia, di chimica
 Giorn. Gen. civ. Giornale del Cenio civile
 Giron. Ist. Lomb. See Bibl. Ital.
 Giorn. Mineral. Crist. Petr. Giornale di Mineralogia, Cristallografia e Petrografia
 Gironde Comm. Meteorol. See Bordeaux Soc. Sci. Mem.
 Gironde, J. Med. Journal Medical de la Gironde
 Gisl, Faunus Faunus
 Glasgow, Inst. Engin. Trans. Transactions of the Institution of Engineers and Ship-builders in Scotland
 Glasgow Med. Chir. Soc. Trans. Transactions of the Medico-Chirurgical Society of Glasgow
 Glasgow Med. J. Glasgow Medical Journal
 Glasgow Natur. Hist. Soc. Proc. & Trans. Proceedings and Transactions of the Natural History Society of Glasgow
 Glasgow Patk. Clifh. Soc. Trans. Transactions of the Glasgow Pathological and Clinical Society

Glasgow Phil. Soc. Proc.	Proceedings of the Philosophical Society of Glasgow
Glashütte	Glashütte, Die
Glas-Ind.	Glas-Industrie, Die
Gleanings Sci.	Gleanings in Science
Globe	See Geneva Soc. Geogr. Mem.
Glückauf	Glückauf; Berg- und Huttenmannische-Zeitschrift
Good Roads	Good Roads
Goodsir, Ann. Anat.	Annals of Anatomy and Physiology
Physiol.	
Gordon Coll. Phot. Assoc.	See Wombat.
Görlitz, Abh.	Abhandlungen der Naturforschenden Gesellschaft zu Görlitz
Götheborg, Handl.	Götheborgs Kongl. Vetenskaps och Vitterhets Samhälles Handlingar
Götheborg, Nya Handl.	Nya Handlingar af Kongl. Vetenskaps och Vitterhets Samhället i Götheborg
Göttingen, Abh.	Abhandlungen der Königlichen Gesellschaft der Wissenschaften zu Göttingen
Göttingen, Comment.	Commentationes recentiores Societatis, etc.
Göttingen, Nachr.	Nachrichten von der Georg-Augusts Universität und der Königl. Gesellschaft der Wissenschaften zu Göttingen
Göttinger Studien	Göttinger Studien
Göttingen, Studien Ver.	Studien des Göttingischen Vereins Bergmännischer Freunde
Gräfe, J. Chir. Augenheilk.	Journal der Chirurgie und Augen-Heilkunde
Graph. Mitth.	Schweizer graphische Mittheilungen
Graubünden Naturf. Ges. Jahr.	Jahresbericht der Naturforschenden Gesellschaft Graubündens
Gravenhage, Athenaeum	Athenaeum
Gravenhage, Inst. Ingen. Tijdschr.	Tijdschrift van het Koninklijk Instituut van Ingenieurs
Gravenhage, Inst. Ingen. Uittrek.	Uittreksels uit Vreemde Tijdschriften voor de Leden van het Koninklijk Instituut van Ingenieurs
Gravenhage, Inst. Ingen. Verh.	Verhandelingen van het Koninklijk Instituut van Ingenieurs
Gravenhage, Inst. Ingen. Verslag.	K. Instituut van Ingenieurs. Algemeen Verslag van de Werkzaamheden en Notulen der Vergaderingen
Gravenhage, Tijdschr.	Tijdschrift voor Entomologie, door de Nederlandsche Entomologische Vereeniging
Graves, Natur. J.	The Naturalists' Journal and Miscellany
Graz Bot. Inst. Mitth.	Mittheilungen aus dem Botanischen Institute zu Graz
Graz, Unters. Physiol. Histol.	Untersuchungen aus dem Institute für Physiologie und Histologie
Great. Brit. Phil. Soc.	See Victoria Inst. J.
Greifswald Naturwiss. Ver. Mitth.	See Neu-Vorpommern Mitth.
Grenoble, Acad. Delph. Bull.	Bulletin de l'Academie Delphmale, ou Société des Sciences et Arts de Grenoble
Grevillea	Grevillea, a Quarterly Record of Cryptogamic Botany and its Literature
Groningen, Ann. Acad.	Annales Academiae Groninganae
Gruttfusen, Neue Analect.	Neue Analecten für Erd- und Himmelskunde
Grunert Archiv.	Archiv für Mathematik und Physik
Grunert, Meteor. Optik	Beiträge zur meteorologischen Optik, etc.
Guat. P.	Guatemala Patent

Guia Minero	Guia del Minero. Periodico científico, industrial y mercantil
Guillemin, Arch. Bot.	Archives de Botanique, ou Recueil Mensuel de Mémoires originaux, etc.
Gummi-Ztg.	Gummi-Zeitung
Günsburg, Zts. Klin. Med.	Zeitschrift für klinische Medizin, mit dem Verein für physiologische Heilkunde in Breslau
Gurtl. Mag. Ges. Thierheilk.	Magazin für die gesammte Thier-Heilkunde
Guy's Hosp. Rep.	Guy's Hospital Reports
Haarlem Kolon. Mus. Bull.	Bulletin van het Koloniaal Museum te Haarlem
Haarlem, Mus. Teyler Arch.	Archives du Musée Teyler
Haarlem, Natuurk. Verh. Maatsch. Wet.	Natuurkundige Verhandelingen van de (Bataafsche) Hollandsche Maatschappij der Wetenschappente Haarlem
Haaxman, Tijdschr.	Tijdschrift voor Wetenschappelijke Pharmacie, etc.
Habana Acad. Anales.	Anales de la (Real) Academie de Ciencias Medicas Fisicas y Naturales de la Habana
Haeser, Arch. Méd.	Archiv für die gesammte Medicin
Hage	See Gravenhage
Hahnemann. Month.	Hahnemannian Monthly, Philadelphia
Haidinger, Abh.	Naturwissenschaftliche Abhandlungen
Haidinger, Ber.	Berichte über die Mittheilungen von Freunden der Naturwissenschaften in Wien
Hainaut Soc. Mem.	Memoires et Publications de la Société des Sciences, des Arts et des Lettres du Hainaut
Hall, Bijdragen	Bijdragen tot de Natuurkundige Wetenschappen
Halle, Abr. Naturwiss. Ver.	Abhandlungen des Naturwissenschaftlichen Vereins für Sachsen und Thüringen in Halle
Halle aux cuirs, La	Halle aux cuirs, La
Halle, Jahr. Naturwiss. Ver.	Jahresbericht des Naturwissenschaftlichen Vereins in Halle
Halle Kryptog. Lab.	See Beitr. Physiol. Morphol.
Halle, Naturf. Ges. Abh.	Abhandlungen der Naturforschenden Gesellschaft zu Halle
Halle, Naturf. Ges. Ber.	Bericht der Naturforschenden Gesellschaft zu Halle
Halle, Naturf. Ges. Neu. Schr.	Neue Schriften der Naturforschenden Gesellschaft zu Halle
Halle, Zts. Ges. Naturwiss.	Zeitschrift für die gesammten Naturwissenschaften
Hamburg, Abh. Geb. Naturwiss.	Abhandlungen aus dem Gebiete der Naturwissenschaften
Hamburg Bot. Ges.	See Bot. Centrbl.
Hamburg, Mitth.	Mittheilungen aus den Verhandlungen der Naturwissenschaftlichen Gesellschaft in Hamburg
Hamb. Mus. Ber.	Naturhistorisches Museum zu Hamburg. Berichte
Hamb. Mus. Jahr.	Jahresbericht über das Naturhistorische Museum zu Hamburg
Hamb. Mus. Mitth.	Mittheilung aus dem Naturhistorischen Museum in Hamburg
Hamb. Naturwiss. Ver. Abh.	Abhandlungen aus dem Gebiete der Naturwissenschaften herausgegeben vom Naturwissenschaftlichen Verein in Hamburg
Hamb. Ver. Naturwiss. Unterh. Verh.	Verhandlungen des Vereins für Naturwissenschaftliche Unterhaltung zu Hamburg
Hamb. Wiss., Anst. Jahr.	Jahrbuch der Hamburgischen Wissenschaftlichen Anstalten

Hampshire Field Club Pap. & Proc.	Papers and Proceedings of the Hampshire Field Club
Hannover Architekt.-Ver. Zts.	Zeitschrift des Architekten- und Ingenieur-Vereins zu Hannover. Zeitschrift für Architektur und Ingenieurwesen
Hannover Jahr.	... Jahresbericht der Naturhistorischen Gesellschaft zu Hannover
Hannöversiche Ann.	Hannoversche Annalen für die gesammte Heilkunde
Harlem Soc. Holland. Sci.	See Arch. Neerland
Hartford, Trans.	Transactions of the Natural History Society of Hartford
Harvard Mus. Zool. Mem.	Memoirs of the Museum of Comparative Zoology at Harvard College
Harvard Mus. Zool. Bull.	Bulletin of the Museum of Comparative Zoology at Harvard College, in Cambridge
Harz, Naturwiss. Ver. Ber.	Berichte des Naturwissenschaftlichen Vereins des Harzes zu Blankenburg
Havre, Cercle Bot.	Cercle pratique d'Horticulture et de Botanique de l'arrondissement du Havre: Bulletins
Haw. P.	Hawaiian Patent
Haye	See Congr. Int. Hyg. C. R., 1884
Heart	Heart
Hedwigia	Hedwigia. Ein Notizblatt für Kryptogamische Studien nebst Repertorium für Kryptogamische Literatur. Hedwigia. Organ für (specielle) Kryptogamenkunde (und Phytopathologie) nebst Repertorium für (Kryptogamische) Literatur
Heidelb. Jahr. Lit.	Jahrbücher der Literatur. Verhandlungen des Naturhistorisch-Medicinischen Vereins zu Heidelberg
Heidelb. Naturhist. Med. Festschr.	Festschrift zur Feier des funfhundertjährigen Bestehens der Ruperto-Carola dargebracht von dem Naturhistorisch-Medicinischen Verein zu Heidelberg
Heidelb. Naturhist. Med. Verh.	Verhandlungen des Naturhistorisch-Medicinischen Vereins zu Heidelberg
Heidelb., Verh.	Verhandlungen der in Heidelberg versammelten Augenärzte
Heis, Wochenschr.	Wochenschrift für Astronomie, Meteorologie, und Geographie
Heller, Archiv.	Archiv für physiologische und pathologische Chemie und Mikroskopie
Helsingfors, Acta Soc. Sci. Fenn.	Acta Societatis Scientiarum Fennicae
Helsingfors, Bidrag Finlands Natur o. Folk.	Bidrag till kannedom om Finlands Natur och Folk, utgifna af Finska Vetenskaps-Societeten
Helsingfors, Bidrag Finlands Naturkänn.	Bidrag till Finlands Naturkannedom, Etnografi och Statistik, utgifna af Finska Vetenskaps-Societeten
Helsingfors, Faun. Flor. Fenn. Acta.	Acta Societatis pro Fauna et Flora Fennica
Helsingfors, Fauna Flora Fenn. Medd.	Meddelanden af Societas pro Fauna et Flora Fennica
Helsingfors, Faun. Flor. Fenn. Notiser	Notiser ur Sällskapets pro Fauna et Flora Fennica Förhandlingar
Helsingfors, Öfvers, Finaka Vet. Soc.	Öfversigt af Finska Vetenskaps-Societätens Förhandlingar
Helv. Chim. Acta	Helvetica Chimica Acta
Henle und Pfeufer, Zts.	See Zeitschrift für rationelle Medicin
Hermannstader Verh.	Verhandlungen und Mittheilungen des Siebenbürgischen Vereins für Naturwissenschaften in Hermannstadt

- Hermbstätt, Archiv. Archiv der 'Agriculturchemie für denkende Land-
wirthe
- Hermstädt, Bull. Bulletin des Neuesten und Wissenwürdigsten aus der
Naturwissenschaft, etc.
- Hermbstätt, Museum Museum des Neuesten und Wissenwürdigsten aus
dem Gebiete der Naturwissenschaft, der Künste,
der Fabriken, der Manufakturen, der technischen
Gewerbe, der Landwirthschaft, der Produkten-
waaren und Handelskunde, und der bürgerlichen
Haushaltung, &c.
- Hertha Hertha
- Herts. Natur. Hist. Soc. Transactions of the Hertfordshire Natural History
Society and Field Club
- Hessen, Naturhist. Verg. Verhandlungen des Naturhistorischen Vereins für des
Grossherzogthum Hessen und Umgebung
- Heßinger, Zts. Zeitschrift für die organische Physik
- Hide and Leather Hide and Leather
- High Wycombe Natur. Hist. Mag. The Quarterly Magazine of the High Wycombe Natural
History Society
- Highland Soc. Trans. Transactions of the Highland and Agricultural Society
of Scotland with an abstract of the Proceedings
- Hildesheim Roemer-Mus. Mittheilungen aus dem Roemer-Museum Hildesheim
Mitth.
- Himly, Biol. Ophthalm. Bibliothek für Ophthalmologie
- Hippone See Bone
- Hisinger, Afh. Afhandlingar i Fysik, Kemi, och Mineralogie
- Hobart Town See Tasmania
- Hoeven en Vriese, Tijdschr. Tijdschrift voor Natuurlijke Geschiedenis en Physio-
logie
- Hoff, Mag. Magazin für die gesammte Mineralogie, Geognosie,
etc.
- Hoffman, Phytogr. Blatt. Phytographische Blätter
- Holl. P. Holland Patent
- Holländ, Beitr. Holländische Beiträge zu den anatomischen und
physiologischen Wissenschaften
- Holländ, Mag. Holländisches Magazin der Naturkunde
- Holmesdale Natur. Hist. Proceedings and Annual Reports of the Holmesdale
Club Proc. Natural History Club, Reigate, for the years 1865-67
- Homme L'Homme: Journal illustre des Sciences Anthro-
pologiques
- Hooker, Bot. Miscell. The Botanical Miscellany
- Hooker, Comp. Bot. Mag. Companion to the Botanical Magazine
- Hooker, Lond. J. Bot. London Journal of Botany
- Hoppe, Bot. Taschenb. Neues Botanisches Taschenbuch für die Anfänger
dieser Wissenschaft und der Apothekerkunst
- Horae Soc. Entom. Rossi- Horae Societatis Entomologicae Rossicae variis ser-
cae monibus Rossicae usitatis
- Horkel, Archiv. Archiv. für die thierische Chemie
- Horn, Archiv. Med. Archiv. für praktische Medizin und Klinik
- Horn's Phot. J. Horn's photographisches Journal
- Hornschuch, Archiv. Archiv Skandinavischer Beiträge zur Naturgeschichte
- Horolog. J. The Horological Journal
- Hortic. Soc. J. Journal of the Royal Horticultural Society of London
- Hortic. Soc. Trans. Transactions of the Horticultural Society of London
- Häfeland, J. Arzn. Journal der practischen Arzneikunde
- Humboldt. Humboldt. Monatsschrift für die Gesanten Natur-
wissenschaften
- Humming Bird The Humming Bird. . . . scientific, artistic and in-
dustrial Review

Hongkong P.	Hongkong Patent
Hung. P.	Hungarian Patent
Hutm. Ztg.	Deutsche Hutmacher-Zeitung
Hyg. Congr.	See Congr. Int. Hig. Act.; Congr. Int. Hyg. C. R.; Int. Congr. Hyg. Arb.; Int. Congr. Hyg. Trans.
Hyg. Rundschau.	Hygienische Rundschau, Berlin
Hyg. viande	Hygiene de la viande et du lait, L'
Iekaterinenb., Soc. Oural.	Bulletin de la Société Ouralienne d'Amateurs des Sciences Naturelles
Bull.	
Il Berico	Il Berico
Il Cimento	Il Cimento
Il Giamb-Vico	Il Giambattista-Vico
Il Progresso	Il Progresso delle Scienze, Lettere ed Arti.
Il Subalpino	Il Subalpino, Giornale di Scienze
Il Tempo	Il Tempo, Giornale Italiano di Medicina
Ill. Insects Rep.	... Report of the State Entomologist... on the Noxious and Beneficial Insects of the State of Illinois
Ill. Lab. Natur. Hist. Bull.	Bulletin of the Illinois State Laboratory of Natural History
Ill. Mus. Natur. Hist. Bull.	Bulletin of the Illinois State Museum of Natural History
Illiger, Magazin	Magazin für Insektenkunde
Illumin. Engin. (London)	Illuminating Engineer (London), The
Illust. Hortic.	Illustration horticole; journal special des Serres et des Jardins
Illust. landw. Ztg.	Illustrierte landwirtschaftliche Zeitung
Illust. Off. J.	Illustrated Official Journal, The (Patents)
Illust. Wochenschr. Entom.	Illustrierte Wochenschrift für Entomologie. Inter- nationales Organ für alle Interessen der Insekten- kunde. Offizielles Organ der Berliner Entomolo- gischen Gesellschaft
Impr.	L'imprimerie
Ind. Chim.	Industria chimica
Ind. lait.	L'Industrie laitière
Ind. Text.	L'industrie textile
Ind. Ztg.	Deutsche Industrie Zeitung
Index Med.	Index Medicus, Washington
India Agric. Soc. J.	Journal of the Agricultural and Horticultural Society of India
India, Agric. Soc. Proc.	Proceedings of the Agricultural and Horticultural Society of India
India Agric. Soc. Trans.	Transactions of the Agricultural and Horticultural Society of India
India Bot. Surv. Records	Records of the Botanical Survey of India
India Dept. Agric.	India Department of Agriculture, Publications
India, Govt. Records (For. Dept.)	Selections from the Records of the Government of India. (Foreign Department)
India, Govt. Records (Home Dept.)	Selections from the Records of the Government of India
India P.	Indian Patent
India Rev.	India Review and Journal of Foreign Science and the Arts
India Rub. J.	India Rubber Journal
India Rub. World	India Rubber World
Indian Ann.	Indian Annals of Medical Science
Indian J. Med. Phys. Sci.	Indian Journal of Medical Science
Indian Med. Gaz.	The Indian Medical Gazette, a monthly record of Medicine, &c.

Indian Meteorol. Mem.	Indian Meteorological Memoirs: being occasional Discussions and Compilations of meteorological data relating to India and the neighboring countries
Indian Mus. Notes	Indian Museum Notes
Industrieztg. Ungarn	Industriezeitung für Ungarn
Ingenieur	Der Ingenieur
Inghirami, Opuscoli	Nuova Collezione di Opuscoli e Notizie di Scienze
Innsbruck, Jahr.	Jahresbericht der k. k. Ober-Realschule zu Innsbruck
Innsbruck, Naturwiss. Med. Ber.	Berichte des Naturwissenschaftlich-medizinischen Vereines in Innsbruck
Innsbruck, Neue Zts.	Neue Zeitschrift des Ferdinandeums für Tirol
Innsbruck, Zts. Ferdinandeums	Zeitschrift des Ferdinandeums für Tirol und Voralberg
Inst.	L'Institut
Inst. Act. J.	Journal of the Institute of Actuaries (and Assurance Magazine)
Inst. Brewing Trans.	Transactions of the Institute of Brewing
Inst. Civ. Eng. Proc.	Minutes of the Proceedings of the Institution of Civil Engineers
Inst. Egypt. Bull.	Bulletin de l'Institut Egyptien
Inst. Egypt. Mem.	Memoires (ou Travaux originaux) presentes (et lus) a l'Institut Egyptien
Inst. Elect. Engin. J.	Journal of the Institution of Electrical Engineers
Inst. Mechan. Engin. Proc.	Institution of Mechanical Engineers. Proceedings
Inst. Min. Eng. Trans.	Transactions of the Institution of Mining Engineers
Inst. Min. Met. Trans.	Transactions of the Institution of Mining and Metallurgy
Inst. Solvay Trav.	Institut Solvay. Travaux de Laboratoire
Intell. Observer	The Intellectual Observer
Intl. Beitr. Path. Therap.	Internationale Beiträge zur Pathologie und Therapie, die Ernährungsstörungen, Stoffwechsel und Verdauungskrankheiten
Intl. Congr. Appl. Chem.	International Congress of Applied Chemistry
Intl. Congr. Hyg. Trans.	Transactions of the International Congress of Hygiene and Demography
Intl. Congr. Zool. Proc.	Proceedings International Congress of Zoology
Intl. Entom. Ver.	See Zürich, Soc. Ent.
Intl. Med. Congr. Trans.	Transactions of the International Medical Congress
Intl. Med. Congr. Verh.	Verhandlungen des Internationalen Medicinischen Congresses
Intl. J. Anat.	Monthly International Journal of Anatomy and Histology (Physiology)
Intl. Mschr. Anat.	See Intl. J. Anat.
Intl. Sugar J.	International Sugar Journal, The
Intl. Zentr. Baukeram. Glasind.	Internationales Zentralblatt für Baukeramik und Glasindustrie
Intl. Zts. Metallog.	Internationale Zeitschrift für Metallographie
Invent. Rec.	Inventor's Record, The
Iowa Acad. Sci. Proc.	Proceedings of the Iowa Academy of Sciences
Iowa Univ. Lab. Natur. Hist. Bull.	Bulletin from the Laboratories of Natural History of the State University of Iowa
Ireland, Coll. Physicians Trans.	Transactions of the Association of Fellows and Licentiates of the King's and Queen's College of Physicians in Ireland
Ireland, Inst. Civ. Eng. Trans.	The Transactions of the Institute of Civil Engineers of Ireland

- Ireland Roy. Soc. Ant. See Dublin Roy. Soc. Ant. Ir. Jl.
 Proc. & Pap.
 Ireland Zool. Soc. • • See Irish Natlist
 Iris Correspondenz-Blatt des Entomologischen Vereins
 Iris zu Dresden. Iris, Dresden. Deutsche Entomologische Zeitschrift herausgegeben von der Gesellschaft Iris zu Dresden in Verbindung mit der Deutschen Entomologischen Gesellschaft zu Berlin.
 Fortsetzung des "Correspondenz-Blattes des Entomologischen Vereins Iris"
 Irish Acad. Cunningham Royal Irish Academy. Cunningham Memoirs
 Mem.
 Irish Acad. Proc. • Proceedings of the Royal Irish Academy
 Irish Acad. Trans. The Transactions of the Royal Irish Academy
 Irish Natur. The Irish Naturalist: a monthly Journal of general Irish Natural History
 Iron Iron
 Iron Age Iron Age
 Iron Coal Trades Rev. Iron Coal Trades Review
 Iron Steel Inst. J. The Journal of the Iron & Steel Institute
 Iron Steel Inst. Trans. Transactions of the Iron and Steel Institute
 Isenflamm, Beitr. Zerglied. Beiträge für die Zergliederungskunst
 Isere Soc. Bull. Bulletin de la Société de Statistique, des Sciences naturelles et des Arts industriels du Département de l'Isère
 Isle of Man Natur. Hist. & See Yn Lioar Manninagh
 Antiq. Soc.
 Ital. P. Italian Patent
 Italia, Soc. Bot. Bull. Bullettino della Società Botanica Italiana
 Italia Soc. Crittog. Atti Atti della Società Crittogamologica Italiana
 Italia Soc. Crittog. Comment. Commentario della Società Crittogamologica Italiana
 Italia Soc. Crittog. Mem. Memorie della Società Crittogamologica Italiana
 Italia, Soc. Entom. Bull. Bullettino della Società Entomologica Italiana
 Italia, Soc. Zool. Boll. Bollettino della Società Zoologica Italiana
 Ithaca, Cornell Univ. Bull. Bulletins of American Paleontology
 Amer. Paleont.
 J. Journal
 J. A. C. S. Journal of the American Chemical Society
 J. Adv. Therap. Journal of Advanced Therapeutics, New York
 J. Agric. • The (Quarterly) Journal of Agriculture
 J. Agric. Hort. Journal de l'Agriculture, le Horticiculture, etc.
 J. Agric. Prat. • Journal d'Agriculture pratique, etc.
 J. Agric. Sci. Journal of Agricultural Science
 J. Agric. Soc. Journal of the Agricultural Society
 J. Agric. Tropicale Journal d'Agriculture tropicale
 J. allied Soc. Journal of the Allied Societies (Dental)
 J. Amer. Lea. Chem. Assoc. • Journal of the American Leather Chemists' Association
 J. Amer. Med. Assoc. Journal of the American Medical Association
 J. Amer. Pharm. Assoc. Journal of the American Pharmaceutical Association
 J. Amer. Soc. Mechan. Eng. • Journal of the American Society of Mechanical Engineers
 J. Anal. Chem. The Journal of Analytical (and Applied) Chemistry
 J. Anat. Journal de l'anatomie de la Physiologie normales et pathologiques de l'homme et des animaux
 J. Anat. Physiol. The Journal of Anatomy and Physiology
 J. Appl. Chem. Journal of Applied Chemistry

J. Appl. Micr.	Journal of Applied Microscopy
J. Assoc. Eng. Soc.	Journal of the Association of Engineering Societies
J. Biol. Chem.	Journal of Biological Chemistry
J. Bot.	Journal de Botanique
J. Buchdr.	Journal für Buchdruckerkunst
J. C. S.	Journal of the Chemical Society, London
J. Camera Club	Journal of the Camera Club
J. Can. Min. Inst.	Journal of the Canadian Mining Institutes
J. Chem. Met. Soc. South Af.	Journal of the Chemical, Metallurgical and Mining Society of South Africa
J. chim. med.	Journal de chimie medicale, de pharmacie et de toxicologie
J. chim. phys.	Journal de chimie, physique, electrochemie, thermochimie, radiochimie, mechanique, chimie, stœchiometrie
J. Chir.	Journal de Chirurgie
J. Chir. Augenheilk.	Journal der Chirurgie und Augenheilkunde
J. Coll. Agric. Imp. Univ. Tokyo	Journal of the College of Agriculture, Imperial University of Tokyo
J. Comp. Path. Therap.	The Journal of Comparative Pathology and Therapeutics
J. Conch.	The Journal of Conchology
J. ecole poly.	Journal de l'Ecole polytechnique
J. Entom.	Journal of Entomology, descriptive and geographical
J. Exp. Med.	Journal of Experimental Medicine
J. Exp. Zool.	Journal of Experimental Zoology, The
J. fabr. sucre	Journal des fabricants de sucre
J. Frank. Inst.	Journal of the Franklin Institute
J. Gasbeleucht.	Journal für Gasbeleuchtung
J. Gaslighting	Journal of Gas Lighting
J. Gen. Physiol.	Journal of General Physiology
J. Genie Civ.	Journal du Genie Civil des Sciences et des Arts
J. Geol.	Journal of Geology
J. Goldschm.	Journal der Goldschmiedekunst und verwandter Gewerbe
J. Heb. Med.	Journal Hebdomadaire de Medecine
J. Heb. Sci. Med.	Journal Hebdomadaire des Progres des Sciences et Institutions Medicales
J. Home Econ.	Journal of Home Economics, The
J. Hygiene	Journal of Hygiene
J. Ind. Eng. Chem.	Journal of Industrial and Engineering Chemistry
J. Indian Archipel.	Journal of the Indian Archipelago and Eastern Asia
J. Infect. Dis.	Journal of Infectious Diseases
J. Inst. Brewing	Journal of the Institute of Brewing
J. Inst. Metals	Journal of the Institute of Metals
J. Intl. Anat.	See Int. J. Anat.
J. Invent.	Journal des Inventeurs
J. Landw.	Journal für Landwirtschaft
J. Med. Chir. Pharm.	Journal de Medecine, Chirurgie, Pharmacie
J. Med. Paris	Journal de medicine de Paris
J. Med. Research	Journal of Medical Research
J. Microgr.	Journal de micrographie
J. Micro. Sci.	Quarterly Journal of Microscopical Science
J. Mines	Journal des Mines, ou Recueil de Memoires sur l'exploitation des Mines, et sur les Sciences et les Arts qui s'y rapportent
J. mines met.	Journal des mines et de metallurgie
J. Morphol.	Journal of Morphology

J. Mus. Godeffroy	Journal des Museum Godeffroy. Geographische, Ethnographische und Naturwissenschaftliche Mittheilungen
J. Mycol.	The Journal of Mycology
J. N. Engl. Water Works Assoc.	Journal New England Water Works Association
J. Ophthalmol.	Journal d'Ophthalmologie
J. Ornith.	Journal für Ornithologie
J. Papier	Journal de Fabricants de Papier, fondé et publié par L. Piette
J. Path. Bact.	The Journal of Pathology and Bacteriology
J. Petrole	Journal du petrole
J. Pharm.	Journal de Pharmacie
J. Pharm. Anvers	Journal de Pharmacie d'Anvers
J. Pharm. Chim.	Journal de Pharmacie et de Chimie
J. Pharm. Elsass-Lothringen	Journal de pharmacie von Elsass-Lothringen
J. Pharm. Soc. Japan	Yakagakuzasshi (Journal of the pharmaceutical society of Japan)
J. Pharmacol.	Journal of Pharmacology and Experimental Therapeutics
J. Phot. Suppl.	Journal of Photographic Supplies
J. Phot. Soc.	Journal of the Photographic Society
J. Phys.	Journal de Physique theorique et appliquee
J. Phys. Chem.	The Journal of Physical Chemistry
J. Phys. Chim.	Journal de Physique, de Chimie, et de l'Histoire Naturelle
J. Physiol.	The Journal of Physiology
J. physiol. path. gen.	Journal de physiologie et de pathologie general, Paris
J. prakt. Chem.	Erdmann's Journal für praktische Chemie
J. Psychol. Med.	Journal of Psychological Medicine and Mental Pathology
J. Roy. Agric. Soc.	Journal of the Royal Agricultural Society
J. Roy. Astron. Soc. Canada	Journal of the Royal Astronomical Society of Canada
J. Roy. Inst. Pub. Health	Journal of the Royal Institute of Public Health
J. Roy. San. Inst.	Journal of the Royal Sanitary Institute
J. Roy. Soc. N. S. Wales	Journal of the Royal Society of New South Wales
J. Roy. U. S. Inst.	Journal Royal United Service Institution
J. Russ. Phys. Chem. Soc.	Journal of the Russian Physical Chemical Society
J. S. C. I.	Journal of the Society of Chemical Industry
J. Savants	Journal des Savants
J. Sci.	The Journal of Science
J. sci. math. physi. nat.	Journal de ciencias mathematicas, physicas naturales
J. Soc. Arts	Journal of the Royal Society of Arts
J. Soc. Dyers Col.	Journal of the Society of Dyers and Colorists
J. soc. pharm. Anvers	Journal de pharmacie, organe de la société de pharmacie d'Anvers
J. Soc. Electr. Eng.	Journal of the Society of Telegraphic Engineers
J. State Med.	The Journal of State Medicine
J. suisse chim. pharm.	Journal suisse de chimie et pharmacie
J. Travel	The Journal of Travel and Natural History
J. Trop. Med.	The Journal of Tropical Medicine
J. U. S. Artill.	Journal of the United States Artillery
J. Univ. Med.	Journal universel et hebdomadaire de Medecine et de Chirurgie pratiques et des Institutions medicales
J. Univ. Sci. Med.	Journal Universel des Sciences Medicales
J. Wash. Acad. Sci.	Journal of the Washington Academy of Sciences
J. Western Soc. Eng.	Journal of the Western Society of Engineers

Jaarb. Mijnw. Nederl. Ind.	Jaarboek van het Mijnwezen in Nederlandsch Oost-Indie
Jahr. = Jahresbericht	Jahrbuch
Jahr. Agrik.-Chem.	Jahresbericht über die Fortschritte der Agrikulturchemie mit besonderer Berücksichtigung der Pflanz- enchemie und Pflanzenphysiologie
Jahr. Berg- u. Hüttenw.	Jahrbuch für das Berg- und Huttenwesen im König- reiche Sachsen
Jahr. Kinderheilk.	Jahrbuch für Kinderheilkunde und physische Erzieh- ung
Jahr. Chem.	Jahresbericht der Chemie (Liebig-Kopp)
Jahr. Gähr. Org.	Jahresbericht über die Fortschritte in der Lehre von den Gährungs-Organismen (Koch)
Jahr. Mineral.	Neues Jahrbuch für Mineralogie, Geologie und Palaeon- tologie
Jahr. Mineral Beil.-Bd.	Neues Jahrbuch für Mineralogie, Geologie, und Palaeontologie, Beilage-Band
Jahf. Pharm.	Jahresbericht der Pharmacie
Jahr. Phot.	Jahrbuch der Photographie (Bder)
Jahr. Phot. Reprod.	Jahrbuch für Photographie und Reproduktionstechnik
Jahr. Phy. Ver. Frank- furt	See Frankfurt, Jahr. Phys. Ver.
Jahr. Physiol.	Jahresbericht über die Fortschritte der Physiologie
Jahr. Radioactiv. Elec- tronik.	Jahrbuch der Radioaktivität und Electronik
Jahr. rein. Chem.	Jahresbericht der reinen Chemie
Jahr. Tier-Chem.	Jahresbericht über die Fortschritte der Tier-Chemie
Jahr. wiss. Bot.	Jahrbucher für wissenschaftliche Botanik
Jamaica Inst. J.	Journal of the Institute of Jamaica
Jamaica P.	Jamaica Patent
Jamaica Soc Arts. Trans.	Transactions of the Jamaica Society of Arts
Jamain, Archives Oph- thalm.	Archives d'Ophthalmologie
Jap. P.	Japanese Patent
Jardine, Mag. Zool. Bot.	The Magazine of Zoology and Botany
Jena Ann. Acad.	Annales Academiae Jenensis
Jena Ann. Phys. Med.	Die Jenaischen Annalen für Physiologie und Medicin
Jenâ Ann. Soc. Mineral	Annalen der Societät für die gesammte Mineralogie zu Jena
Jena Denkschr.	Denkschriften der Medicinisch-Naturwissenschaft- lichen Gesellschaft zu Jena
Jena Geogr. Ges. Mitth.	Mittheilungen der geographischen Gesellschaft (für Thüringen) zu Jena
Jena Sitzber.	Sitzungsberichte der Jenaischen. Gesellschaft für Medicin und Naturwissenschaft
Jena Zts.	Jenaische Zeitschrift für Naturwissenschaft herausge- geben von der Medicinisch-naturwissenschaft- lichen Gesellschaft zu Jena
Jern-Kontoret's Ann.	Jern-Kontoret's Annaler
Johns Hopkins Biol. Lab. Mem.	Memoirs from the biological laboratory of the Johns Hopkins University
Johns Hopkins Biol. Lab. Stud.	Johns Hopkins University. Studies from the Bio- logical Laboratory
Johns Hopkins Univ. Circ.	The Johns Hopkins University Circulars
Jura, Trav. Soc. Emul.	Travaux de la Société d'Emulation du Department du Jura
Jurjew	See Dorpat
Just's bot. Jahr.	Just's botanischer Jahresbericht, Leipzig and Berlin
Kali	Kali

Kampen, Mag.	Magazin voor Wetenschappen, Kunsten, &c.
Kan. Acad. Sci. Trans.	Transactions of the . . . annual meeting of the Kansas Academy of Science
Kan. Univ. Quart.	The Kansas University Quarterly
Karlsruhe Bact. Inst. Arb.	Arbeiten aus dem bacteriologischen Institut der technischen Hochschule zu Karlsruhe
Karlsruhe Naturwiss. Ver. Verh.	Verhandlungen des Naturwissenschaftlichen Vereins in Karlsruhe
Kärnten, Berg-Verein, Zts.	Zeitschrift des Berg- u. Huttenmännischen Vereins für Kärnten
Kärnten Landesmus. Jahr.	Jahrbuch des naturhistorischen Landes-Museums von Kärnten
Kärnten, Zts.	Zeitschrift des berg- und hüttenmännischen Vereines für Kärnten
Karsten	See Botan. Untersuch.
Karsten, Archiv.	Archiv für Mineralogie, Geognosie, Bergbau, und Huttenkunde
Kassel Ver. Naturk. Ber.	Bericht des Vereins für Naturkunde zu Cassel
Kassel Ver. Naturk. Festschr.	Festschrift des Vereins für Naturkunde zu Cassel zur Feier seines Fünfzigjährigen Bestehens
Kastner, Archiv. Chem.	Archiv. für Chemie und Meteorologie
Kastner, Archiv. Naturlehre	Archiv. für die gesammte Naturlehre
Kazan Soc. Phys.-Math. Bull.	Bulletin de la Société Physico-Mathématique de Kazan
Kazan Soc. Natur. Proc.	Proceedings of the Physico-Mathematical Section of the Society of Naturalists of the Imperial University of Kazan
Kazan Soc. Natur. Trans.	Transactions of the Society of Naturalists of the Imperial University of Kazan
Kazan Univ. Bull.	Bulletin of the Imperial University of Kazan
Kazan Univ. Mem.	Scientific Memoirs of the Imperial University of Kazan
Kekule, Krit. Zts. Chem.	Kritische Zeitschrift für Chemie, Physik, und Mathematik; see also Zts. Chem.
Keram. Rundschau	Keramische Rundschau
Kew Bull.	Royal (Botanic) Gardens, Kew. Bulletin of Miscellaneous Information
Kharkov. Math. Soc. Commun.	Communications de la Société Mathématique de Kharkov
Kiel. Mitth. Ver. Elbe.	Mittheilungen des Vereins nördlich der Elbe zur Verbreitung naturwissenschaftlicher Kenntnisse in Kiel
Kiel, Physiol. Inst. Arb.	Arbeiten aus dem Kieler physiologischen Institut
Kiel, Schr.	Schriften der Universität zu Kiel
Kiel Univ. Mineral. Inst. Mitth.	Mittheilungen aus dem Mineralogischen Institut der Universität Kiel
Kiev Soc. Natur. Mem.	Memoires de la Société des Naturalistes de Kiev
Kjöbenh. Bot. For.	See Bot. Tidsskr.
Kjöbenh. Bot. For. Festskr.	Festskrift, udgivet af den Botaniske Forening i Kjöbenhavn i Anledning af dens Halvhundredaars fest, den 12 April, 1890
Kjöbenh. Bot. For. Medd.	Meddelelser fra den Botaniske Forening i Kjöbenhavn
Kjöbenh. Carlsb. Lab. Medd.	Meddelelser fra Carlsberg Laboratorium
Kjöbenh. Dansk. Vid. Selsk. Afh.	Det Kongelige Danske Videnskabsnævn Selskabs naturvidenskabelige og mathematiske Afhandlinger

Kjöbenh., Dansk. Vid. Selsk. Skrift.	Det Kongelige Danske Videnskabernes Selskabs Skrifter. Naturvidenskabelig og Mathematisk Afdeling
Kjöbenh. Ent. For.	See Ent. Medd. (Kjöbenh.)
Kjöbenh., Oversigt	Oversigt over det Kongelige Danske Videnskabernes Selskabs Forhandlinger og dets Medlemmers Arbejder i Aaret 1874(-83)... samt. med en Résumé du Bulletin de l'Académie Royale Danoise des Sciences et des Lettres pour l'année 1874(-83)
Kjöbenh., Reg. Soc. Med. Acta.	Acta Regiae Societatis Medicae Havniensis
Kjöbenh., Vidensk. Forh.	Videnskabelige Forhandlinger ved Siølland Stifts Landemøde
Kjöbenh., Vidensk. Meddel.	Videnskabelige Meddelelser fra den Naturhistoriske Forening i Kjøbenhavn
K. K. Ges. Aerzte	See Med. Jahr
Klausenburg	See Kolozsvár
Kliniek	Kliniek
Klug, Jahr. Insect.	Jahrbücher der Insectenkunde, etc.
Koll. Chem. Beihefte	Kolloidchemische Beihefte
Kolloid-Zts.	Kolloid-Zeitschrift
Kolozsvár Orvos-Termesz. Tarsa. Értes.	Értesítő a "Kolozsvári Orvos-Termesztudományi Társulat" -nak az ... orvosi, természetstudományi szakulacsirol ... Proceedings of the Medical and natural history sections of the Klausenburg Medical and Natural History Society
K. Svenska Vet-Akad.	Kongl. Svenska Vetenskaps-Akademiens Handlingar
Königsb. Archiv.	Königsberger Archiv für Naturwissenschaften und Mathematik
Königsb. Med. Jahr.	Königsberger medicinische Jahrbücher; herausgegeben von dem Verein für wissenschaftliche Heilkunde zu Königsberg
Königsb. Schr.	Schriften der physikalisch-ökonomischen Gesellschaft zu Königsberg in Preussen
Kosmos (Lwow)	Kosmos. Czasopismo polskiego Towarzystwa przyrodników imienia Kopernika. (Cosmos. The Journal of the Polish Society Naturalists founded in honor of Copernicus)
Krain Mus.-Ver. Mitth.	See Laibach, Mus.-Ver. Krain Mitth.
Krakow Akad. (Mat.-Przyrod.) Pam.	Pamiętnik Akademii Umiejętności w Krakowie. Wydział Matematyczno-Przyrodniczy. (Memoires of the Academy of Science in Cracow. Section of Mathematics and Natural Science)
Krakow Akad. (Mat.-Przyrod.) Rozpr.	Rozprawy i Sprawozdania z Posiedzeń Wydziału Matematyczno-Przyrodniczego Akademii Umiejętności. (Proceedings of the Section of Mathematics and Natural Science of the Academy of Science)
Krakow, Akad. (Mat.-Przyrod.) Rozpr. & Spraw.	Rozprawy i Sprawozdania z Posiedzeń Wydziału Matematyczno-Przyrodniczego Akademii Umiejętności. (Proceedings of the Section of Mathematics and Natural Science of the Academy of Science)
Krakow Kom. Fizyogr. Spraw.	Akademija Umiejętności w Krakowie. Sprawozdanie Komisji Fizyograficznej ... (Academy of Science in Cracow. Report of the Physiographical Commission)
Krakow, Roczn. Nauk.	Rocznik Towarzystwa Naukowego z Uniwersytetem Jagiellońskim Złączonego
Krakau, Untersuch. Path. Anat.	Untersuchungen aus dem Pathologisch-Anatomischen Institute in Krakau

Kreutzer's Jahr. Phot.	Kreutzer's Jahresbericht der Photographie
Kristiania, Geogr. Selsk. Arb.	Det Norske Geografiske Selskabs Arbog
Kristiania, Norw. Mar. Investig. Rep.	Report on Norwegian Fishery and Marine Investigations
Kroyer, Naturhist. Tidssk.	Naturhistorisk Tidsskrift
Kühn-Archiv.	Kühn-Archiv. (formerly Berichte aus dem physiologischen Laboratorium und der Versuchsanstalt des Landwirtschaftlichen Instituts der Universität Halle)
Kult. Ing.	Der Kultur-Ingenieur (F. Dunkelberg)
Kunst.	Kunststoffe
Lab. Club. Trans.	Transactions of the Laboratory Club
Laboratory	The Laboratory
Laibach, Jahr. Gymnas.	Jahresbericht des k. k. Ober-Gymnasiums in Laibach
Laibach, Jahr. Realschule	Jahresbericht der k. k. selbständigen Unter-Realschule zu Laibach
Laibach, Jahresh.	Jahresheft des Vereins des Krainischen Landes Museums in Laibach
Laibach, Mus.-Ver. Krain Mitth.	Mittheilungen des Museal-Vereins für Krain
Lancet	The Lancet, London
Landb. Cour.	Landbouw-Courant
Landshut Bot. Ver. Ber.	Bericht des Botanischen Vereines in Landshut
Landw. Centr.	Landwirtschaftliches Centralblatt für Deutschland
Landw. Jahr.	Landwirtschaftliche Jahrbücher. Zeitschrift für wissenschaftliche Landwirtschaft und Archiv. des Königlich Preussischen Landes-Oekonomie-Kollegiums
Landw. Jahr. Schweiz	Landwirtschaftliches Jahrbuch der Schweiz
Landw. Presse	Landwirtschaftliche Presse
Landw. Versuchs-Stat.	Die landwirtschaftlichen Versuchs-Stationen
Landw. Ztg.	Landwirtschaftliche Zeitung
Laon, Soc. Acad. Bull.	Bulletin de la Société Académique de Laon
Laurent Ann. Anat.	Annales Françaises et Etrangères d'Anatomie et de Physiologie, appliquées à la Médecine et à l'Histoire Naturelle
Laurent Gerhardt, Compt. rend.	Comptes rendus Mensuels des Travaux Chimiques
Lausanne, Bull. Soc. Med.	Bulletin de la Société Médicale de la Suisse Romande
Lausanne, Bull. Soc. Vaud.	Bulletin des Seances de la Société Vaudoise des Sciences Naturelles
Lausitz. Monatschr.	Lausitzische (und neue Lausitzische) Monatschrift Organ der Oberlausitzischen Gesellschaft der Wissenschaften
Leather	Leather
Leather Mfr.	Leather Manufacturer
Leather Tr. Rev.	Leather Trades Review
Leather World	Leather World, The
Lederind.	Lederindustrie (Deutsche Gerber-Zeitung)
Ledermarkt	Ledermarkt, Der. (See also Collegium)
Leeds, Trans. Phil. Soc.	Transactions of the Philosophical and Literary Society of Leeds
Leicester, Lit. Phil. Soc. Selection	Selection of Papers, of the Literary and Philosophical Society of Leicester
Leicester Soc. Rep.	Leicester Literary and Philosophical Society. Report of the Council
Leicester Soc. Trans.	Transactions of the Leicester Literary and Philosophical Society

Leide	See Leyden
Leiden, Ann. Acad.	Annales Acadëmiæ Lugduno-Batavæ
Leiden, Tijdschr. Entom.	Tijdschrift voor Entomologie
Leipzig, Abh. Jablon. Ges.	Abhandlungen bei Begründung der k. Sächsischen Gesellschaft der Wissenschaften am Tage der zweihundertjährigen Geburtsfeier Leibnizens
Leipzig, Abh. Math. Phys.	Abhandlungen der Mathematisch-Physischen Classe der Königlich Sächsischen Gesellschaft der Wissenschaften
Leipzig, Arbeit. Physiol. Anst.	Arbeiten aus der physiologischen Anstalt zu Leipzig
Leipzig, Astron. Ges. Viertelj.	Vierteljahrsschrift der Astronomischen Gesellschaft
Leipzig, Ber. Math. Phys.	Berichte über die Verhandlungen (Math. Phys. Classe) der Königlich Sächsischen Gesellschaft der Wissenschaften zu Leipzig
Leipzig, Färb. Ztg.	Leipziger Färber- und Zeugdrucker-Zeitung
Leipzig, Jablon. Preisschr.	Preisschriften gekrönt und herausgegeben von der fürstlich Jablonowski'schen Gesellschaft zu Leipzig
Leipzig, Monatsschr. Text. Ind.	Leipziger Monatsschrift für Textil Industrie
Leipzig, Naturf. Ges. Sitzber.	Sitzungsberichte der Naturforschenden Gesellschaft zu Leipzig
Leipzig, Physiol. Anst. Arb.	Arbeiten aus der Physiologischen Anstalt zu Leipzig
Leipzig, Schr. Naturf. Ges.	Schriften der Naturforschenden Gesellschaft zu Leipzig
Leipzig, Verh. Med. Ges.	Verhandlungen der Medicinischen Gesellschaft
Leyden Mus. Notes	Notes from the Leyden Museum
Leo, Mag.	Magazin für Heilkunde und Naturwissenschaft in Pohlen
Leoben, Berg. u. Hütt. Jahr.	Berg- und Huttenmannisches Jahrbuch der k. k. Montan. Lehranstalten zu Leoben und Pribram
Leonhard Bronn	See Neues Jahr. Mineral
Leonhard Bronn, Jahr.	Jahrbuch für Mineralogie, Geognosie, Geologie, und Petrefaktenkunde
Leonhard Bronn, Neu. Jahr.	Neues Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde
Leonhard, Taschenbuch	Taschenbuch für die gesammte Mineralogie
Leonhard, Zts.	Zeitschrift für Mineralogie
Leopold.-Carol. Deutsch. Akad. Naturf.	See Ac. Nat. Curios. Nova Acta. Leopoldina
Leopoldina	Leopoldina. Amtliches Organ der Kaiserlichen Leopoldino-Carolinischen Deutschen Akademie der Naturforscher
Letters on Brewing	Letters on Brewing
Les Mondes	Revue hebdomadaire des Sciences et de leurs application
Licht.	Licht: Zeitschrift für Photographie: herausgegeben vom Photographischen Verein. zur Berlin
Liege, Ann. Acad.	Annales Academiae Leodiensis
Liege Assoc. Ingen. Annu.	See Rev. Univ. Mines
Liege, Mem. Soc. Emul.	Memoires de la Société Libre d'Émulation de Liege
Liege, Mem. Soc. Sci.	Memoires de la Société (Royale) des Sciences de l'Agriculture, et des Arts a Liege
Leige Lab. Fredericq Trav.	Université de Liege. Institut de Physiologie. Travaux du Laboratoire de Leon Fredericq
Lille Inst. Zool. Trav.	Travaux de l'Institut Zoologique de Lille et du Laboratoire de Zoologie Maritime de Wimereux (Pas-de-Calais). Travaux de la Station Zoologique de Wimereux

Lille Mem. Soc.	Memoires de la Société (Imperiale) des Sciences, de l'Agriculture et des Arts de Lille
Lille, Mem. Soc. Sci.	Memoires de la Société (Royale) des Sciences, etc., a Lille
Lille, Seances Publ.	Seances Publiques de la Société des Amateurs
Lille, Trav.	Recueil des Travaux de la Société d'Amateurs des Sciences, de l'Agriculture, et des Arts a Lille
Lille, Trav. Mem.	Travaux et Memoires de l'Universite de Lille
Lima, Mem. Cien. Nat.	Memorias de Ciencias Naturales y de Industrial (Lima)
Limbourg, Soc. Sci. Bull.	Bulletin de la Société Scientifique et Litteraire du Limbourg
Limoges, Assises	Assises scientifiques de Limoges (Institut des Provinces de France)
Lindblom, Bot. Notiser	Botaniska Notiser
Linn	Linnaea: ein Journal fur die Botanik
Linn Entom.	Linnaea Entomologica
Linn. Soc. J.	The Journal of the Linnean Society. Botany and Zoology
Linn. Soc. Trans.	The Transactions of the Linnean Society of London
Linn. Soc. Proc.	Proceedings of the Linnean Society of London
Linneska Samf. Handl.	Linneska Samfundets Handlingar for ar 1832
Linz, Ber.	Bericht über das Museum Franciscus-Carolinum in Linz
Lisboa, Acad. Sci. Mem.	Historia e Memorias da Academia Real das Sciencias de Lisboa
Lisboa, Actas	Actas das Sessoes da Academia Real das Sciencias de Lisboa
Lisboa, Ann.	Annaes das Sciencias e Lettras
Lisboa, J. Math. Sci.	Jornal de Sciencias Mathematicas, Physicas e Naturaes publicado sob os Auspicios da Academia Real das Sciencias de Lisboa
Litterar. Annal.	Litterarische Annalen der gesammten Heilkunde
Liverpool Biol. Soc. Proc.	Proceedings and Transactions of the Liverpool Biological Society
Liverpool, Lit. Phil. Soc. Proc.	Proceedings of the Literary and Philosophical Society of Liverpool
Liverpool Mar. Biol. Comm.	See Liverpool Biol. Soc. Proc; Liverpool Biol. Soc. Proc. & Trans.; Liverpool Lit. Phil. Soc. Proc.
Liverpool Med. Chir. J.	Liverpool Medico-Chirurgical Journal
Liverpool School Trop. Med. Mem.	Liverpool School of Tropical Medicine. Memoirs
Liverpool, Thompson Yates Lab. Rep.	The Thompson Yates Laboratories Report
Loc. Gov. Bd. Rep. (Med. Off.)	Annual Report of the Local Government Board Supplement containing the Reports of the Medical Officer
London	See Int. Congr. Hyg. Trans., 1891; Int. Congr. Zool. Proc. 1898
London, Ann. Med. Surg.	Annals of Medicine and Surgery, Records of the occurring Improvements, &c.
London, Cryst. Soc. Proc.	Proceedings of the Crystallogical Society
London Elec. Soc. Proc.	Proceedings of the London Electrical Society
London, Fed. Inst. Brewing J.	Journal of the Federated Institutes of Brewing containing the Transactions of the various Institutes
London J. Med.	London Journal of Medicine
London, Med. Phys. J.	The Medical and Physical Journal
London, Med. Soc. Trans.	Transactions of the Medical Society of London

London, Obstet. Soc. Trans.	Transactions of the Obstetrical Society of London
London, Odont. Soc. Trans.	Transactions of the Odontological Society of London
London Path. Soc. Trans.	Transactions of the Pathological Society of London
Lond. Phot. Soc.	London Photographic Society
London Phys. Soc. Proc.	Proceedings of the Physical Society of London
London Physiol. J.	London Physiological Journal
London Poly. Rev.	The London Polytechnic Review and Magazine
London, Poly. Mag.	Polytechnic Magazine and Journal of Science, Letters, and Fine Arts
London, Sci. Soc. Proc.	Proceedings of the Scientific Society of London
London, Soc. Imp. Med. Trans.	Transactions of the Society for the Improvement of Medical and Chirurgical Knowledge
Lotos	Lotos, Jahrbuch für Naturwissenschaft im Auftrage der Vereines "Lotos"
Louisiana Planter	Louisiana Planter and Sugar Manufacturer, The
Louvaine, Ann. Acad.	Annales Academiae Lovaniensis
Lowell Obs. Ann.	Annals of the Lowell Observatory
Lucca, Atti Accad.	Atti della R. Accademia Lucchese di Scienze, Lettere, et Arti
Lumière	La Lumière; Revue de la Photographie
Lumière elec.	Lumière électrique, La
Lund, Acta Univ.	Acta Universitatis Lundensis. Lunds Universitets Års-skrift. Afdelningen för Matematik och Naturvetenskap
Lund Bot. For.	See Bot. Centrbl.; Bot. Notiser
Lund, Phys. Sällsk. Tidskr.	Physiografiska Sällskapets Tidskrift
Lüneb., Denkschr.	Denkschriften des naturwissenschaftlichen Vereins für das Fürstenthum Lüneburg
Lüneb., Jahr. Naturwiss. Ver.	Jahresbericht über die Thatigkeit des naturwissenschaftlichen Vereins in Lüneburg
Lüneb. Jheft. Naturwiss. Ver.	Jahreshefte des Naturwissenschaftlichen Vereins für das Fürstenthum Lüneburg
Luxemb., Inst. Roy. Publ.	Publications de l'Institut Royal Grand-Ducal de Luxembourg: Section des Sciences Naturelles
Luxemb. P.	Luxembourg Patent
Luxemb. Soc. Bot. Rec. Mem. Trav.	Recueil des Memoires et des Travaux publiés par la Société Botanique du Grand-Duché de Luxembourg
Luxemb. Soc. Sci. Natur.	Société des Sciences Naturelles du Grand-Duché de Luxembourg
Lyon	Lyon scientifique et industriel
Lyon, Acad. Sci. Mem.	Memoires de l'Academie des Sciences, Belles-Lettres, et Arts de Lyon
Lyon Mus. Hist. Natur. Archiv.	Archives du Muséum d'Histoire naturelle de Lyon
Lyon Soc. Agric. Ann.	Annales de la Société d'Agriculture, Histoire naturelle et Arts utiles de Lyon. Annales de la Société d'Agriculture, Sciences et Industrie de Lyon
Lyon Soc. Bot. Ann.	Annales de la Société Botanique de Lyon
Lyon, Soc. Linn. Ann.	Annales de Société Linneenne de la Lyon
Lyon, Soc. Linn. Compt. rend.	Comptes Rendus des Travaux de la Société de Medecine
Lyon, Soc. Sci. Med. Mem.	Memoires et Comptes-Rendus de la Société des Sciences Medicales de Lyon
Lyon Univ. Ann.	Annales de l'Universite de Lyon
Maandbl. Natuurweten.	Maandblad voor Natuurwetenschappen, uitgegeven door de Sectie voor Natuurwetenschappen van het Genootschap ter Bevordering van Natuur- en Heelkunde te Amsterdam

- Maclurian Lyceum, Contrib. Contributions of the Maclurian Lyceum to the Arts and Sciences
- Macon Acad. Ann. Annales de l'Academie de Macon. Société des Arts, Sciences, Belles-Lettres et (d')Agriculture (de Saone-et-Loire)
- Macon, Soc. Agric. Compt. rend. Comptes Rendus des Travaux de la Société d'Agriculture, Sciences, et Belles-Lettres
- Macon Soc. Compt. rend. Compte Rendu des Travaux de la Société (d'Agriculture), des Sciences, Arts et Belles-lettres, de Macon
- Madras J. The Madras Journal of Literature and Science
- Madras Quart. J. Madras Quarterly Journal of Medical Science
- Madrid See Congr. Int. Hig. Act. 1898
- Madrid Acad. Cien. Mem. Memiores de la Real Academia de Ciencias Exactas, Fisicas y Naturales de Madrid
- Madrid, Anales Hist. Natur. Anales de Historia Natural
- Madrid, Anales Minas Anales de Minas
- Madrid, Anuar. Anuario del Real Observatorio de Madrid
- Madrid, Bol. Boletin Oficial del Ministerio de Comercio
- Madrid, Ingen. Ind. Anales Anales de la Asociacion de Ingenieros Industriales
- Madrid, Mem. Memorias de la Real Academia de Ciencias
- Madrid, Revista Revista de los Progresos de las Ciencias exactas, fisicas, y naturales
- Madrid, Soc. Hist. Natur. Anales de la Sociedad Espanola de Historia Natural
- Mag. Gesamt. Thierheilk. Magazin fur die gesammte Thierheilkunde
- Mag. Natur. Hist. The Magazine of Natural History, and Journal of Zoology, Botany, Mineralogy, Geology, and Meteorology
- Mag. Natur. Phil. The Magazine of Natural Philosophy
- Mag. Naturvid. Magazin for Naturvidenskaberne
- Mag. Zool. Magasin de Zoologie
- Magdeb. V. Ver. Abh. Abhandlungen des Naturwissenschaftlichen Vereins zu Magdeburg
- Magdeb. V. Ver. Festschr. Festschrift zur Feier des 25. jahrigen Stiftungstages des Naturwissenschaftlichen Vereins zu Magdeburg
- Magdeb. V. Ver. Jahr. Abh. Jahresbericht und Abhandlungen des naturwissenschaftlichen Vereins in Magdeburg
- Magendie, J. Physiol. Journal de Physiologie, experimentale et pathologique
- Magyar Akad. Ertes. Magyar Akademiai Ertesito A matematikai, es Termeszettudomanyi osztalyok kozlonye (Report of the Hungarian Academy. Communications of the Mathematical and Natural Science Sections)
- Magyar Boripar Magyar Boripar
- Magyar Nemzeti Muzeum See Termr. Fuz.
- Magyar Term. Tars. See Term. Kozlon.
- Magyar Tud. Akad. Ertes. A Magyar Tudomanyos Akademia Ertesitoje. (Report of the Hungarian Academy of Science)
- Magyar Tud. Akad. Ertek. (Math.) Ertekezések a Matematikai Tudomanyok köreibol. Kiadja a Magyar Tudomanyos Akademia (Memoirs in the Mathematical Sciences. Published by the Hungarian Academy of Science)

Magyar Tud. Akad. Ertek. (Termt.)	Ertekezések a Természettudományok köréből. Kiadja a Magyar Tudományos Akadémia. (Memoirs in the Natural Sciences. Published by the Hungarian Academy of Science)
Magyar Tud. Akad. Evk.	A Magyar Tudományos Akadémia Évkönyvei. (Annals of the Hungarian Academy of Science)
Maine Loire Soc. Mem. Acad.	Memoires de la Société Academique de Maine et Loire
Majocchi, Ann. Fis. Chim.	Annali di Fisica, Chimica, etc.
Malpighia	Malpighia. Rassegna mensile di Botanica
Malta P.	Malta Patent
Malvern Field Club Trans.	The Transactions of the Malvern Naturalists' Club
Manufact. and Build.	The Manufacturer and Builder
Manchester Engin. Proc.	Proceedings of the Manchester Institution of Engi- neers
Manchester, Lit. Phil. Soc. Mem.	Members of the Literary and Philosophical Society of Manchester
Manchester, Lit. Phil. Soc. Proc.	Proceedings of the Literary and Philosophical Society of Manchester
Manchester Micro. Soc. Trans.	Manchester Microscopical Society. Transactions and Annual Report
Manchester, Owens Coll. Biol. Lab. Stud.	Studies from the Biological Laboratories of the Owens College
Manchester, Owens Coll. Stud. Biol.	Studies in Biology from the Biological Department of the Owens College
Mannheim, Jahr.	Jahresbericht des Mannheimer Vereins für Natur- kunde
Mans, Soc. Agric. Bull.	Bulletin de la Société d'Agriculture, etc., de la Sarthe
Mans, Soc. Bull.	Bulletin de la Société (Royale) d'Agriculture, Sciences et Arts du Mans
Mans, Soc. Roy. Trav.	Analyse des Travaux de la Société (Royale) des Arts du Mans
Marburg, Ges. Naturwiss. Schr.	Schriften der Gesellschaft zur Beförderung der gesamten Naturwissenschaften zu Marburg
Marianini	See Mem. Fis. Sperim.
Marne, Soc. Agric. Compte Annuel	Compte annuel et Sommaire des Travaux de la Société Agricole, etc., du département de la Marne
Marne, Soc. Agric. Seance	Seance publique de la Société d'Agriculture, etc., du département de la Marne
Marseille, Ann. Sci.	Annales de Sciences et de l'Industrie du midi de la France
Marseille Fac. Sci. Ann.	Annales de la Faculté des Sciences de Marseille
Marseille Lab. Zool. Mar. Trav.	See Marseille Mus. Ann.
Marseille, Mem. Acad	Memoires publics par l'Académie de Marseille
Marseille, Mem. Soc. Emul.	Memoires de la Société d'Émulation de la Provence
Marseille Mus. Ann.	Annales du Musée d'Histoire naturelle de Marseille
Maschin.-Constr. Maschinenb.	Der praktische Maschinen-Construkteur (W. Uhland) Der Maschinenbauer
Mass. Bd. Health Report	Annual Report of the State Board of Health, Lunacy and Charity of Massachusetts. Annual Report of the State Board of Health of Massachusetts
Mass. Insects Report	... Annual Report on the Injurious and Beneficial In- sects of Massachusetts
Mass. Med. Soc. Commqn. Mat. grasses	Massachusetts Medical Society's Communications Le Matieres grasses
Maurice, Soc. Hist. Nat'ur. Rapp.	Septieme Rapport Annuel sur les Travaux de la Société d'Histoire Naturelle de l'Le Maurice

Mauritius, Meteorol. Soc. Proc.	Proceedings, &c., of the Meteorological Society of Mauritius
Mauritius, Meteorol. Soc. Trans.	Transactions of the Meteorological Society of Mauritius
Mauritius P.	Mauritius Patent
Mauritius Roy. Soc. Trans.	Transactions de la Société Royale des Arts et des Sciences de Maurice
Meaux, Bull. Soc. Archeol.	Bulletin de la Société d'Archeologie, Sciences, Lettres et Arts du dept. de Seine et Marne
Mechan. Engin. Inst. Proc.	Institution of Mechanical Engineers. • Proceedings
Meckel, Archiv.	Archiv. fur Anatomie und Physiologie
Meckel, Deut. Archiv.	Deutsches Archiv. fur die Physiologie
Med. Assoc. J.	Journal edited for the Provincial Medical and Surgical Association
Med. Bot. Soc. Trans.	Transactions of the Medico-Botanical Society of London
Med. Chem. Unters	Medicinisch-chemische Untersuchungen; aus dem Laboratorium fur angewandte Chemie zu Tubingen
Med. Chir. Soc. Proc.	Proceedings of the Royal Medical and Chirurgical Society of London
Med.-Chir. Trans.	Medico-Chirurgical Transactions
Med. Chir. Ztg.	Medicinisch-chirurgische Zeitung
Med. Congr.	See Congr. Int. Med. C. R., Congr. Int. Sci. Med. C. T., Congr. Med. Int. Atti, Int. Med. Congr. Trans., Int. Med. Congr. Verh.
Med. Jahr.	Medizinische Jahrbücher, von der K. K. Gessellschaft in Wien
Med. Klinik.	Medizinische Klinik
Med. naturwiss. Archiv.	Medizinisch-naturwissenschaftliches Archiv.
Med. Off. India Sci. Mem.	Scientific Memoirs by Medical Officers of the Army of India
Med. Phys. J.	The Medical and Physical Journal
Med. Rec.	The Medical Record, N. Y.
Med. Times	The Medical Times, London
Med. Trans.	Medical Transactions
Med. Wochenschr.	Medizinische Wochenschrift
Med. Ztg. Russ.	Medicinische Zeitung Russlands
Medd. Gronland	Meddelelser om Gronland
Medd. K. Vetenskapsakad. Nobel-inst.	Meddelanden fran K. Vetenskapsakademins Nobel-institut
Meisner, Ann.	Annalen der allgemeinen Schweizerischen Gesellschaft fur die gesammten Naturwissenschaften
Meisner, Anzeiger	Naturwissenschaftlicher Anzeiger der Allgemeinen Schweizerischen Gesellschaft fur die gesammten Naturwissenschaften
Melbourne	See Victoria
Mem. accad. Lincei	Memorie della r. accademia dei Lincei, Classe di scienze fisiche, matematiche e naturali
Mem. Accad. Sci. Torino	Memorie della Reale Accademia delle Scienze di Torino
Mem. Chem. Soc.	Memoirs and proceedings of the Chemical Society of London prior to 1848
Mem. Coll. Sci. Eng. Kyoto	Memoirs of the College of Science and Engineering, Kyoto Imperial University
Mem. Fis. Sperim.	Memorie di Fisica sperimentale
Mem. Imp. Mineral. Soc. Petrograd	Memoirs of the Imperial Mineralogical Society of Petrograd
Mem. Lepidopt., St. Petersb.	Memoires sur les Lepidopteres

Mem. Manch. Lit. Phil. Soc.	Memoirs and Proceedings of the Manchester Literary and Philosophical Society
Mem. Med. Milit.	Recueil de Memoires de Medecine, de Chirurgie et de Pharmacie Militaires
Mem. poud. salp.	Memorial des poudres et salpêtres
Mem. rev. soc. cien. "Antonio Alzate"	Memorias y revista de la sociedad científica "Antonio Alzate"
Mem. Soc. Ing. civ.	Memoires et Compte-Rendu des travaux de la Société des Ingenieurs Civils, etc.
Mem. Soc. Nat. Kiev.	Memoirs of the Society Nat. Kiev.
Mem. Valdarnesi	Memorie Valdarnesi
Mende, Soc. Agric. Bull.	Bulletin de la Société d'Agriculture, Industrie, Sciences, et Arts de département de la Lozere
Mende, Soc. Agric. Mem.	Memoires et Analyses des Travaux de la Société d'Agriculture, Commerce, Sciences, et Arts de la ville de Mende, département de la Lozere
Merk's Ann. Rep.	Merk's Annual Report
Merk's Archiv.	Merk's Archives, New York
Messenger Math.	The Messenger of Mathematics
Met.	Metallurgical-Metallurgia
Met. Chem. Eng.	Metallurgical and Chemical Engineering
Met. ital.	Metallurgia italiana, La
Met. Rev.	The Metallurgical Review
Metal Ind.	The Metal Industry
Metal Tech.	Metal Technik
Metall. Ind. Ztg.	Deutsche Metall-Industrie Zeitung
Metallarb.	Der Metallarbeiter
Metallurgie	Metallurgie
Metaxa, Ann. Med. Chir.	Annali medico chirurgici
Metz Acad. Mem.	Memores de l'Academie (Imperiale) de Metz
Metz, Assises	Assises scientifiques de Metz (Institut des Provinces de France)
Metz, Seance Gen.	Société des Lettres, Sciences, Arts, et Agriculture de Metz
Metz Soc. Hist. Natur. Bull.	Bulletin de la Société d'Histoire naturelle de Metz
Mex.	Mexican, Mexico, Mexicane
Mex. P.	Mexican Patent
Mex. Mus. Anales	Anales del Museo Nacional de Mexico
Mex. Registro Trim.	Registro trimestre, o Coleccion de Memorias de Historia, Literatura, Ciencias, etc., por una Sociedad de Literatos
Mex. Soc. "Alzate" Mem.	Memorias de la Sociedad Científica "Antonio Alzate"
Mexique Archiv. Comm. Sci.	Archives de la Commission Scientifique du Mexique, publies sous les auspices du Ministère de l'Instruction Publique
Meyer Bros. Drug.	Meyer Brothers Druggist, St. Louis
Meyer Jahrb. Chem.	R. Meyer's Jahrbuch der Chemie
Michigan, Fish Comm. Report	Biennial Report of the State Board of Fish Commissioners. (Contains the Michigan Fish Comm. Bull.)
Micro. J.	Quarterly Journal of Microscopical Science
Micro. Soc. J.	Journal of the Royal Microscopical Society
Micro. Soc. Trans.	Transactions of the Microscopical Society of London
Midl. Drug.	Midland Druggist and Pharmaceutical Review
Midl. Med. Surg. Rep.	Midland Medical and Surgical Reporter
Midl. Quart. J. Med. Sci.	The Midland Quarterly Journal of Medical Sciences
Milano, Ann. Scienz.	Annali di Scienze e Lettere

Milano, Atti Ginnas.	Atti dell' I. R. Ginnasio Liceale Convitto Longone in Milano
Milano, Atti Ist. Lomb	Atti dell' I. R. Istituto Lombardo di Scienze, Lettere, ed Arti
Milano, Atti Soc. Ital.	Atti della Società Italiana di Scienze Naturali
Milano, Cagnola Atti	Atti della Fondazione Scientifica Cagnola dalla sua istituzione in poi.
Milano, Giorn. Soc. Incor.	Giornale della Società d'Incoraggiamento delle Scienze, etc., stabilita in Milano
Milano, Ist. Lomb Adunanze	Solenni Adunanze del R. Istituto Lombardo di Scienze e Lettere
Milano, Ist. Lomb. Rapporti	Rapporti sui Progressi delle Scienze del R. Istituto Lombardo di Scienze
Milano, Ist Lomb Rend	Rendiconti dell' Istituto Lombardo di Scienze e Lettere — Classe di Scienze matematiche e naturali
Milano, Mem Ist Lomb.	Memorie dell' I. R. Istituto Lombardo di Scienze, etc.
Milano, Mem Ist Lomb Veneto	Memorie dell' I. R. Istituto del regno Lombardo-Veneto
Milch Zentr	Milchwirtschaftliches Zentralblatt
Milch Ztg.	Milch Zeitung
Min Eng World	Mining and Engineering World
Min J.	The Mining Journal
Min Rev	Mining Review, a Monthly Record of Geology
Min. Sei	Mining Science
Min Sci Press	Mining and Scientific Press
Min Smelt Mag.	The Mining and Smelting Magazine a monthly review of Practical Mining, Quarrying, and Metallurgy
Min Soc. J.	See Min Mag
Mineral Mag	The Mineralogical Magazine and Journal of the Mineralogical Society of Great Britain and Ireland
Mineral Mitth	Mineralogische Mittheilungen
Mineral Petr Mitth	(Tschermak's) Mineralogische und Petrographische Mittheilungen
Mines and Minerals	Mines and Minerals
Minn Acad Sci Bull	Bulletins of the Minnesota Academy of Natural Sciences
Minn Acad Sci Pap	The Minnesota Academy of Natural Sciences at Minneapolis, Minn Occasional Papers
Minn Bot Stud	Geological and Natural History Survey of Minnesota. Minnesota Botanical Studies
Miquel, Bull	Bulletin des Sciences Physiques et Naturelles en Neerlande
Misc Ent.	Miscellanea Entomologica
Mitau, Quatember	Die Quatember
Mitth. Artil. Geniew	Mittheilungen über Gegenstände des Artillerie- und Genie-wesens
Mitth. Böhmen. Archit. Ing. Ver.	Mittheilungen des Architekten und Ingenieur Vereins im Königreiche Böhmen
Mitth. Centralst. Wiss - tech. Unters.	Mittheilungen aus der Centralstelle für wissenschaftlich-technische Untersuchungen
Mitth. Gewerbever. Nassau	Mittheilungen für den Gewerbeverein für Nassau
Mitth. Kais. Gesundhts.	Mittheilungen aus dem Kaiserlichen Gesundheitsamte, Berlin
Mitth. Königl. Material-prüfungsamt	Mittheilungen aus dem Königl. Material prüfungsamt zu Gross Lichterfelde West
Mitth. Hannov. Gewerbever.	Mittheilungen des Gewerbevereins für Hannover

Mitth. Lebensm. Hyg.	Mittheilungen aus dem Gebiete der Lebensmittelunter- suchung und Hygiene veröffentlicht vom Schweizer Gesundheitsamt
Mitth. Malerei	Technische Mittheilungen für Malerei
Mitth. könig. Prüfungsans. Wasser-versorgung	Mittheilungen aus der königlichen Prüfungsanstalt für Wasser-versorgung und Abwässer beseitigung zu Berlin
Mitth. Tech. Gew. Mus.	Mittheilungen aus dem Technischen Gewerbe Museum
Mitth. Techn. Versuch- samtes	Mittheilungen des k. k. Technischen Versuchsamtes
Mitth. Zool. Sta. Neapel	Mittheilungen aus der zoologischen Station zu Neapel. etc.
Mo. Insects Report	Annual Report on the Noxious, Beneficial and other Insects, of the State of Missouri, made to the State Board of Agriculture
Mod. Sugar Planter	Model Sugar Planter, The
Modena, Accad. Sci. Mem.	Memorie della Regia Accademia di Scienze, Lettere ed Arti di Modena
Modena, Annu. Soc. Natur.	Annuario della Società dei Naturalisti in Modena
Modena Atti Soc. Natur.	Atti della Società dei Naturalisti di Modena
Modena, Mem. Soc. Ital.	Memorie di Matematica e di Fisica della Società Italiana delle Scienze
Modena, Relazione	Relazione delle Adunanze della R. Accademia di Scienze, Lettere, ed Arti di Modena, nell' Anno Accademico 1842-43
Moigno, Annu. Cosmos	Annuaire du Cosmos
Mois chim. electrochim.	Mois chimique et electrochimique, Le
Mois min. met.	Mois minier et metallurgique, Le
Mois sci. ind.	Mois scientifique et industriel, Le
Moleschott, Unters.	Untersuchungen zur Naturlehre des Menschen und der Thiere
Moll, Ann.	Annalen der Berg- und Huttenkunde
Moll, Efemeriden	Efemeriden der Berg- und Huttenkunde
Moll, Jahr. Berg.	Jahrbücher der Berg- und Huttenkunde
Moll, Neue Jahr.	Neue Jahrbücher der Berg- und Huttenkunde
Mon. ceram. verr	Moniteur de la ceramique de la verrerie et journal du ceramiste et du chauffournier (reains)
Mon. cord.	Moniteur de la cordonnerie
Mon. fils. tiss.	Moniteur des fils et tissus
Mon. Ind.	Moniteur Industriel
Mon. Ind. Belge	Moniteur Industriel Belge
Mon. Pap.	Moniteur Papeterie
Mon. Sci.	Moniteur Scientifique (Quesneville)
Mon. teint.	Moniteur de la teinture des apprêts et de l'impression des tissus
Monats.	Monatshefte für Chemie und verwandte Theile anderer Wissenschaften Gesammelte Abhand- lungen aus den Sitzungsberichten der kaiserlichen Akademie der Wissenschaften
Monats. Dermatol.	Monatshefte für praktische Dermatologie
Monatsbl. Hannover Gewer- bever.	Monatsblatt des Gewerbevereins für Hanover
Monatschr. Text.-Ind.	Leipziger Monatsschrift für Textil-Industrie
Monatschr. Zahn.	Monatschrift für Zahnärzte
Montevideo Mus. Nac. Anales	Anales del Museo Nacional de Montevideo
Monthly Amer. J. Geol.	The monthly Journal of Geology and Natural Science
Monthly Archiv. Med. Sci.	Monthly Archives of the Medical Sciences

Monthly Cons. & Trade Report	The monthly Consular and Trade Reports
Montpellier, Acad. Procès-Verb.	Extraits des Procès-Verbaux des Seances de l'Academie des Sciences et Lettres
Montpellier, Acad. Sci. Mem.	Academie des Sciences et Lettres de Montpellier
Montpellier Inst. Zool. Trav.	Travaux originaux du Laboratoire Zoolique de la Faculte des Sciences de Montpellier et de la Station Maritime de Cette
Montpellier, Mem. Acad. Sect. Med.	Memoires de l'Academie des Sciences et Lettres: Section de la Medecine
Montpellier, Recueil. Bull.	Recueil des Bulletins publiés par la Société Libre des Sciences, etc.
Montreal Natur. Hist. Soc. Proc.	See Canad. Rec. Sci.
Montreal Pharm. J.	Montreal Pharmaceutical Journal
Montsouris	See under Paris
Morphol. Arb.	Morphologische Arbeiten
Morphol. Jahr.	Morphologisches Jahrbuch
Moscou	See Congr. Int. Anthrop. C. R. 1892, Congr. Int. Med. C. R. 1897, Congr. Int. Zool. (C. M.) 1892
Moscou, Comment. Soc. Phys. Med.	Commentationes Societatis Physico-Medicae apud Universitatem Mosquensem institutae
Moscou, Soc. Natur. Bull.	Bulletin de la Société Imperiale des Naturalistes
Moscou, Soc. Natur. Mem.	Memoires de la Société Imperiale des Naturalistes de Moscous
Moscou, Soc. Natur. Nouv. Mem.	Nouveaux Memoires de la Société Imperiale des Naturalistes de Moscous
Moscow Soc. Sci. Bull.	Bulletin of the Imperial Society of Lovers of Natural Science, Anthropology and Ethnography, in connection with the Imperial University of Moscow
Moscow Univ. Mem. (Natur. Hist.)	Scientific Memoirs of the Imperial University of Moscow. Natural History Section
Moscow Univ. Mem. (Phys.-Math.)	Scientific Memoirs of the Imperial University of Moscow. Physico-Mathematical Section
Moselle, Bull. Soc. Hist. Natur.	Bulletin de la Société d'Histoire Naturelle du departement de la Moselle
Moselle, Trav. Soc. Sci. Med.	Exposé des Travaux de la Société des Sciences Medicales de la Moselle
Mov. Pict. World	Moving Picture World
Mulder, Archief.	Natuur- en Scheikundig Archief.
Mulder, Scheik. Verh.	Scheikundige Verhandelingen en Onderzoekingen
Müller, Archiv.	Archiv. für Anatomie, Physiologie, und wissenschaftliche Medicin.
München, Akad. Abh.	Abhandlungen der Mathematisch-Physikalisch Classe der königlich Bayerischen Akademie der Wissenschaften
München, Akad. Sitzber.	Sitzungsberichte der Mathematisch-Physikalischen Classe der k. B. Akademie der Wissenschaften München
München Bot. Ver.	See Bot. Centrbl.
München, Bull. Akad.	Bulletin der k. Akademie der Wissenschaften
München, Denkschr.	Denkschriften der Königl. Baierischen Akademie der Wissenschaften zu München
München, Entom. Ver. Mitth.	Mittheilungen des Münchener Entomologischen Vereins
München, Gelehrte Anz.	Gelehrte Anzeigen

München Ges. Morphol. Physiol. Sitzber.	Sitzungsberichte der Gesellschaft für Morphologie und Physiologie in München
München, Naturwiss. Tech. Comm. Abh.	Abhandlungen der naturwissenschaftlich-technischen Commission bei der Königl. Baierischen Akademie
München Phot. Ges.	See Wien, Photogr. Correspond.
München, Sitzber.	Sitzungsberichte der Königl. Baierischen Akademie der Wissenschaften zu München
München Thierarznei-Schule Jahr.	Jahresbericht der k. Central-Thierarznei-Schule in München
München Thierärztl. Hochschule Jahr.	Jahresbericht der k. Thierärztlichen Hochschule in München
München, Zts. Arch.	Zeitschrift des Bayerischen Architekten- und Ingenieur-Vereins
Munic. Engin.	Municipal Engineer
Munic. J. Engin.	Municipal Journal and Engineer
Münster, Abh. Aerzt. Ges.	Abhandlungen und Beobachtungen der ärztlichen Gesellschaft zu Münster
Museum Senckenb.	Museum Senckenbergianum
Must. Ztg.	Leipziger Farber Zeitung (Farberei Musterzeitung)
N. Brunsw. Natur. Hist. Soc. Bull.	Bulletin of the Natural History Society of New Brunswick
N. England Bot. Club	See Rhodora
N. Engl. Eng.	New England Engineer, The
N. England J. Med.	New England Journal of Medicine and Surgery.
N. Erf. Erfahr.	Neueste Erfindungen und Erfahrungen
N. Hampshire San. Bull.	New Hampshire Sanitary Bulletin
N. Haven	See Connecticut
N. Idea	New Idea (The), Detroit
N. Med. Phys. J.	New Medical and Physical Journal
N. Mex. Agric. Coll. Bull.	New Mexico Agricultural College. Experiment Station. Las Cruces, N. M. Bulletin. New Mexico College of Agriculture and the Mechanic Arts Agricultural Experimental Station Pulletin
N. Orleans Med. Surg. J.	New Orleans Medical and Surgical Journal
N. Orleans Proc.	Proceedings of the New Orleans Academy of Sciences
N. Russ. Soc. Natur. Mem.	Memoirs of the New Russian Society of Naturalists
N. S. Wales, Acclim. Soc. Report	Annual Reports (3, 6, and 7) of the Acclimatisation Society of N. S. W.
N. S. Wales Dept. Mines Report	Annual Report of the Department of Mines (and Agriculture), New South Wales
N. S. Wales, Entom. Soc. Trans.	The Transactions of the Entomological Society of New South Wales
N. S. Wales Linn. Soc. (Macleay Mem. Vol.)	Linnean Society of New South Wales. The Macleay Memorial Volume
N. S. Wales, Linn. Soc. Proc.	The Proceedings of the Linnean Society of New South Wales
N. S. Wales P.	New South Wales Patent
N. S. Wales, Phil. Soc. Trans.	Transactions of the Philosophical Society of New South Wales
N. S. Wales, Roy. Soc. J.	Journal and Proceedings of the Royal Society of New South Wales
N. S. Wales, Roy. Soc. Trans.	Transactions of the Royal Society of New South Wales
N. Y. Acad. Ann.	Annals of the New York Academy of Sciences, late Lyceum of Natural History
N. Y. Acad. Mem.	New York Academy of Sciences. Memoirs
N. Y. Acad. Trans.	Transactions of the New York Academy of Sciences. Late Lyceum of Natural History

N. Y. Acad. Med. Bull.	Bulletin of the New York Academy of Medicine
N. Y. Acad. Med. Trans.	Transactions of the New York Academy of Medicine
N. Y. Agric. Soc. Trans.	Transactions of the New York State Agricultural Society
N. Y. Bot. Club Bull.	Bulletin of the Torrey Botanical Club
N. Y. Entom. Soc. J.	Journal of the New York Entomological Society
N. Y. Insects Report	Report on the Noxious, Beneficial and other Insects of the State of New York
N. Y. J. Med.	New York Journal of Medicine and the Collateral Sciences
N. Y. Linn. Soc. Trans.	Transactions of the Linnaean Society of New York
N. Y. Lit. Phil. Soc. Trans.	Transactions of the Literary and Philosophical Society of New York
N. Y. Lyceum Ann.	Annals of the Lyceum of Natural History of New York
N. Y. Lyceum, Proc.	Proceedings of the Lyceum of Natural History in the City of New York
N. Y. Med. J.	New York Medical Journal
N. Y. Med. Repos.	Medical Repository of New York
N. Y. Med. Soc. Trans	Transactions of the Medical Society of the State of New York
N. Y. Mus. Bull.	University of the State of New York. Bulletin of the New York State Museum
N. Y. Mus. Mem.	Memoirs of the New York State Museum.
N. Zeal. Inst. Trans.	Transactions and Proceedings of the New Zealand Institute
N. Zeal. Inst. Min. Engin. Trans.	Transactions of the New Zealand Institute of Mining Engineers
N. Zeal. J. Sci	The New Zealand Journal of Science
N. Zeal. P.	New Zealand Patent
N. Zeal. Pap. & Rep.	New Zealand. Papers and Reports relating to Minerals and Mining
Nachr. konig. Ges.	Nachrichten von der koniglichen Gesellschaft der Wissenschaften zu Gottingen (Mathematisch-physikalische Klasse)
Nancy, Acad. Stanislas. Mem.	Academie de Stanislas Memoires de la Société (Royale) des Sciences, etc., de Nancy
Nancy Soc. Sci. Bull.	Bulletin de la Société des Sciences de Nancy
Nancy Soc. Sci. Mem.	Memoires de la Société (Royale) des Sciences, Lettres, et Arts de Nancy
Nancy Soc. Sci. Trav.	Precis analytique des Travaux de la Société (Royale) des Sciences, Arts, et Agriculture de Nancy
Nantes J. Med.	Journal de la Section de Medecine de la Société Academique du departement de la Loire Inferieure
Nantes, Ann. Soc. Acad.	Annales de la Société Academique de Nantes et du departement de la Loire Inferieure
Nantes Soc. Sci. Natur. Bull.	Bulletin de la Société des Sciences naturelles de l'Ouest de la France
Napoli Accad. Aspir. Ann.	Annali della Accademia degli aspiranti Naturalisti
Napoli Accad. Atti	Atti della Reale Accademia delle Scienze Fisiche e Matematiche
Napoli Accad. Pontan. Atti	Atti dell' Accademia Pontaniana
Napoli Accad. Sci. Atti	Atti della Reale Accademia della Scienze e Belle Lettere; Sezione della Società R. Borbonica
Napoli Accad. Sci. Mem.	Memorie della R. Accademia della Scienze
Napoli Giorn. Mat.	See Giornale di Matemat.
Napoli, Atti Ist. Incorr.	Atti del Real Istituto d'Incoraggiamento alle Scienze Naturali di Napoli

<i>Napoli Lucifero</i>	<i>Il Lucifero</i>
<i>Napoli Mus.</i>	Museo di Letteratura e Filosofia
<i>Napoli, Ann. Mus. Zool.</i>	Annuario del Museo Zoologico della R. Università di Napoli
<i>Napoli Rend.</i>	Rendiconto dell' Accademia delle Scienze Fisiche e Matematiche. (Sezione della Società Reale di Napoli)
<i>Napoli Soc. Natur. Boll.</i>	Bollettino della Società di Naturalisti in Napoli
<i>Natl. Assoc. Retail Drug, Notes</i>	The Journal of the National Association of Retail Druggists, Chicago
<i>Natl. Disp.</i>	National Dispensatory
<i>Natl. Drug.</i>	National Druggist
<i>Natl. Ecl. Med. Assoc. Quart.</i>	The National Eclectic Medical Association Quarterly, Cincinnati
<i>Natl. Glass Budget</i>	National Glass Budget
<i>Natl. Inst. Bull.</i>	Bulletin of the Proceedings of the National Institution for the Promotion of Science
<i>Natur. Can.</i>	Le Naturaliste Canadien. Bulletin de Recherches, Observations et Decouvertes se rapportant a l'Histoire naturelle du Canada
<i>Natur. Sicil.</i>	Il Naturalista Siciliano. Giornale di Scienze Naturali
<i>Natur. J.</i>	The Naturalists' Journal
<i>Naturaleza</i>	La Naturaleza. Periodico cientifico de la Sociedad Mexicana de Historia Natural
<i>Naturalist (Yorks)</i>	The Naturalist: Journal of the West Riding Consolidated Naturalists' Society
<i>Naturaliste</i>	Le Naturaliste
<i>Nature</i>	Nature
<i>Naturf.</i>	Der Naturforscher
<i>Natur. Hist. Review</i>	The Natural History Review and Quarterly Journal of Science
<i>Naturhist. Notizen</i>	Naturhistorische und chemisch-technische Notizen nach den neuesten Erfahrungen
<i>Naturhist. Tidsskr.</i>	Naturhistorisk Tidsskrift
<i>Naturwiss. Umschau Chem. Ztg.</i>	Naturwissenschaftliche Umschau der Chemiker-Zeitung
<i>Natuurk Tijdschr.</i>	Natuurkundige Tijdschrift, inhoudende Phijsica, Chemie, Pharmacie, Nat. Hist., &c., uitg. van wege het Genootschap: "Tot nat en vergenoegen," te Arnhem.
<i>Nauche, J. Galvan.</i>	Journal du Galvanisme, de Vaccine, etc.
<i>Naval Archit. Trans.</i>	Transactions of the Institution of Naval Architects
<i>Naval Sci.</i>	Naval Science: a Quarterly Magazine for promoting the improvement of Naval Architecture, Marine Engineering, Steam Navigation, and Seamanship
<i>Neapel Zool. Sta., Fauna & Flora</i>	Fauna und Flora des Golfes von Neapel und der angrenzenden Meeres-Abschnitte herausgegeben von der Zoologischen Station zu Neapel
<i>Neapel Zool. Sta. Mitth.</i>	Mittheilungen aus der Zoologischen Station zu Neapel
<i>Nebraska Univ. Stud.</i>	University Studies. Published by the University of Nebraska
<i>Nederl. Archiv.</i>	See Selenka
<i>Nederl. Archief Natuurk.</i>	Nederlandsch Archief voor Genees-en Natuurkunde
<i>Nederl. Bot. Ver. Versl. en Meded.</i>	See Nederl. Kruidk. Arch.
<i>Nederl. Dierk. Ver. Tijdschr.</i>	Tijdschrift der Nederlandsche Dierkundige Vereniging
<i>Nederl. Entom. Ver.</i>	See Tijdschr. Ent.

Nederl. Kruidk. Archief.	Nederlandsch Kruidkundig Archief
Nederl. Lancet	Nederlandsch Lancet. Tijdschrift aan de praktische Chirurgie, etc.
Nederl. Tijdschr. Dierkunde.	Nederlandsch Tijdschrift voor de Dierkunde, uitgegeven door het koninklijk Zoologisch Genootschap Natura Artis Magistra te Amsterdam
Nederl. Tijdschr. Geneesk.	Nederlandsch Tijdschrift voor Geneeskunde, tevens orgaan der Nederlandsche Maatschappij tot de Bevordering der Geneeskunst
Neuchatel Soc. Sci. Bull.	Bulletin de la Société des Sciences Naturelles de Neuchatel
Neues Bergmänn J.	Neues bergmännisches Journal
Neues Nord. Min.	Neues Jahrbuch für Mineralogie, Geologie und Palaeontologie
Neues Lausitz. Mag.	Neues Lausitzisches Magazin; unter Mitwirkung der Oberlausitzischen Gesellschaft der Wissenschaften.
Neue med.-chir. Ztg.	Neue medicinisch-chirurgische Zeitung
Neues Nord. Archiv.	Neues nordisches Archiv für Natur und Arzneikunde, verfasst von einer Gesellschaft nordischer Gelehrten
Neue Preuss. Provinz. Blatt.	Neue Preussische Provinzial-Blätter
Neu-Vorpommern Mitth.	Mittheilungen aus dem naturwissenschaftlichen Vereins für Neu-Vorpommern und Rugen in Greifswald
Newbury Field Club Trans.	Transactions of the Newbury District Field Club
Newcastle Chem. Soc. Trans.	Newcastle-upon-Tyne Chemical Society. Transactions
Newf. P.	Newfoundland Patent
Newman. Entom.	The Entomologist
Newport Natur. Hist. Soc. Proc.	Proceedings of the Newport Natural History Society
Nicholson J.	Journal of Natural Philosophy, Chemistry, and the Arts
Nick.	The Nickelodeon
Niederl. Archiv. Zool.	Niederländisches Archiv. für Zoologie
Nideröstrerr. Gewerb-Verh.	Verhandlungen des Niederösterreichischen Gewerbe-Vereins
Niederrhein. Ges. Naturk. Sitzber.	Sitzungsberichte der Niederrheinischen Gesellschaft für Natur- und Heilkunde zu Bonn
Niederrhein. Ges. Organ.	Organ für die gesammte Heilkunde; herausgegeben von der Niederrheinischen Gesellschaft für Natur- und Heilkunde zu Bonn
Nieuw Archief Wisk.	Nieuw Archief voor Wiskunde
Nimes Soc. Sci. Bull.	Bulletin de la Société d'Etude des Sciences Naturelles de Nimes
Nor. Amer. Med. Chir. Rev.	The North-American Medico-Chirurgical Review
Nor. Eng. Inst. Min. Engin. Trans.	North of England Institute of Mining and Mechanical Engineers. Transactions
Nor. Staff. Field Club Rep.	(The) North Staffordshire (Naturalists') Field Club (and Archaeological Society). Annual Report (and Transactions)
Nord. Brabant. Handel. prov. Genoots.	Handelingen van het provinciaal Genootschap van Kunsten en Wetenschappen in Nord Brabant
Nord France Soc. Linn. Bull.	Bulletin de la Société Linnéenne du Nord de la France
Nord France Soc. Linn. Mem.	Memoires de la Société Linnéenne du Nord de la France

- Nord, Mem. Soc. Agric. See Douai
 Nord, Soc. Agric. Seance Seance Publique, de la Société d'Agriculture, Sciences,
 Publ. et Arts, etc., du département du Nord
 Nordamerik. Monatsber. Nordamerikanischer Monatsbericht für Natur- und
 Heilkunde
 Norddeut. Landwirth Der norddeutsche Landwirth
 Nordisches Archiv. Nordisches (u. Neues Nordisches) Archiv. für Natur-
 kunde und Arzneiwissenschaft
 Norf. Norw. Natur. Soc. Transactions of the Norfolk and Norwich Naturalists'
 Trans. Society
 Normandle See Caen
 Normandie Soc. Linn. Bull. Bulletin de la Société Linnéenne de Normandie
 Normandie Soc. Linn. Mem. Memoires de la Société Linnéenne de Normandie
 Normandie Soc. Linn. Seance Publiques de la Société Linnéenne de Nor-
 mandie
 Norsk Tidssk. Vid. Litt. Norsk Tidsskrift for Videnskab og Litteratur.
 Norske Videnskab. Skrift. Det Kongelige Norske Videnskabselskabs Skrifter i
 det 19 de Aarhundrede
 Northampton Natur. Hist. Journal of the Northampton(shire) Natural History
 Soc. J. Society and Field Club
 Northern J. Med. Northern Journal of Medicine
 Northumb. Natur. Hist. Transactions of the Natural History Society of North-
 Soc. Trans. umberland, Durham, and Newcastle-upon-Tyne
 Northwestern Drug. Northwestern Druggist (The), Minneapolis
 Norw. P. Norwegian Patent
 Notarisia. Notarisia. Commentarium Phycologicum. La'
 Notarisia. Commentario Ficologico Generale.
 Parte speciale della Rivista Neptunia
 Notices of Judgment, U. S. Notices of Judgment, U. S. Department of Agricul-
 Dept. Agric. ture
 Notiz. Archit. Vef. Nieder- Notizblatt des Architekten und Ingenieur Vereins
 rhein für Niederrhein und Westfalen
 Notiz. Riga Notizblatt des technischen Vereins zu Riga
 Nouv. Ann. Math. Nouvelles Annales de Mathematiques
 Nouv. Archiv. Miss. Sci. Nouvelles Archives des Missions Scientifiques et
 Litteraires
 Nouv. remedes Nouveaux remedes, Paris
 Nova Acta Acad. Nat. Novorum Actorum Academiae Caesarcae Leopoldino-
 Curbs. Carolinae Germanicae Naturae Curiosorum
 Nova Scotia Inst. Sci. Proc. (The) Proceedings and Transactions of the Nova
 & Trans. Scotian Institute of (Natural) Science
 Nova Scotia, Trans. Lit. Transactions of the Literary and Scientific Society of
 Sci. Soc. Nova Scotia
 Novitates Zool. Novitates Zoologicae. A Journal of Zoology in
 connection with the Tring Museum
 Nuov. Ann. Sci. Natur. Nuovi Annali delle Scienze naturali
 Nuov. Antol. Sci. Nuova Antologia di Scienze, Lettere (Lettere, Scienze)
 ed Arti
 Nuov. Cimento Il Nuovo Cimento, Giornale di Fisica, di Chimica, e
 di Storia Naturale
 Nuov. Giorn. Bot. Ital. Nuovo Giornale Botanico Italiano (e Bullettino della
 Società Botanica Italiana)
 Nuov. Notarisia. La Nuova Notarisia. Rassegna (trimestrale) con-
 sacrata allo Studio delle Alghe (e Corollario alla
 "Sylloge Algarum Omnium")
 Nurnb. Natur. Ges. Abh. Abhandlungen der Naturhistorischen Gesellschaft zu
 Nürnberg
 Nye Hygaea Nye Hygaea

Nyt Mag. Naturvid.	Nyt Magazin for Naturvidenskaberne
Nyt Tidsskr. Fys. Kemi.	Nyt Tidsskrift for Fysik og Kemi.
Oberhess. Ges. Ber.	Berichte der Oberhessischen Gesellschaft für Naturkunde und Heilkunde in Giessen
Odontol. Soc. Trans.	Transactions of the Odontological Society of Great Britain
Oesterr. Bot. Zts.	Oesterreichische Botanische Zeitschrift
Oesterr. Chem. Ztg.	Oesterreichische Chemiker Zeitung
Oesterr. landw. Wochenbl.	Oesterreichisches landwirtschaftliches Wochenblatt
Oesterr. Med. Jahr.	Medicinisches Jahrbuch des k. k. Oesterreichischen Staates
Oesterr. Med. Wochenschr.	Oesterreichische Medicinische Wochenschrift, als Ergänzungsblatt der medicinischen Jahrbücher
Oesterr. Wochenschr.	Oesterreichische Wochenschrift für Wissenschaft, Kunst, und öffentliches Leben
Oesterr. Zts. Berg. Huttenw.	Oesterreichische Zeitschrift für Berg- und Hüttenwesen
Oesterr.-ung. Zts. Zuckerind.	Oesterreichisch-ungarische Zeitschrift für Zuckerindustrie und Landwirtschaft
Off. Gaz.	Official Gazette, United States Patent Office
Offenbach. Ver. Naturk. Ber.	Bericht des Offenbacher Vereins für Naturkunde über seine Thätigkeit
Oil Colour J.	Oil and Colourman's Trade Journal
Oil, Paint Drug Rep.	Oil, Paint and Drug Reporter
Oise	See Beauvais
Oise Mem. Soc. Acad.	Memoires de la Société Academique d'Archologie, Sciences, et Arts du departement de l'Oise
Oken Isis	Isis, oder Encyclopädische Zeitung
Omaha Drug.	Omaha Druggist (The), Omaha
Omodei Ann. Univ.	Annali Universali di Medicina
Ontario Entom. Soc. Rep	Report of the Entomological Society of Ontario
Oporto	See Porto
Ophthalm. Bibliothek	Ophthalmologische Bibliothek
Ophthalm. Hosp. Reports	Ophthalmic Hospital Reports and Journal of the Royal London Ophthalmic Hospital
Ophthalmic Rev.	The Ophthalmic Review a Quarterly Journal of Ophthalmic Surgery and Science
Organ Rubenzuckerind	Organ des Centralvereins für Rubenzuckerindustrie
Orgelb.	Die Orgelbauzeitung
Orleans Ann.	Annales de la Société Royale des Sciences, Belles-Lettres, et Arts d'Orleans
Orleans, Bull	Bulletin des Sciences Physiques, Medicales, et d'Agriculture d'Orleans
Ornis	Ornis, oder das Neueste und Wichtigste der Vogelkunde, etc.
Ornith. Jahr.	Ornithologisches Jahrbuch
Ornith. Monatsber.	Ornithologische Monatsberichte
Ornithol.	The Ornithologist
Ornithol. Ool.	The Ornithologist and Oologist
Örsted Tidsskrift	Tidsskrift for Naturvidenskaberne
Orvos-Termesz. Ertes	Orvos-Termeszettudományi Értesítő a Kolozsvári Orvos-Termeszettudományi Tarsulat és az Erdélyi. Museum-Egyet. Termeszettudományi Szakosztálynak az. szaküléséről. (Medical and Natural History Proceedings of the sections of the Klausenburg Medical and Natural History Society and of the Natural History section of the Museum Association of Transylvania)

Osnabrück, Jahr.	Jahresbericht des Naturwissenschaftlichen Vereins zu Osnabrück
Ottawa Field-Natur. Club Trans.	Ottawa Field-Naturalists' Club Transactions
Ottawa Natur.	The Ottawa Naturalist
Ouest France Soc. Sci. Nat. Bull.	Sec Nantes...
Oversigt K. Danske Vidensk. Selsk. Forh.	Oversigt over det Kongelige Danske Videnskabskabernes Selskabs Forhandlinger
Pacific Drug. Rev.	Pacific Drug Review, Portland
Pacific Pharm.	Pacific Pharmacist
Padova, Mem. Acad.	Memorie dell' Accademia di Scienze, Lettere, ed Arti di Padova
Padova, Nuovi Saggi	Nuovi Saggi dell' Accademia di Scienze, Lettere, ed Arti di Padova
Padova, Rivista Period.	Rivista Periodica dei Lavori della I. R. Accademia di Scienze, Lettere, ed Arti di Padova
Padova, Soc. Sci. Atti	Atti della Società Veneto-Trentina di Scienze naturali
Padova Soc. Sci. Bull.	Bullettino della Società Veneto-Trentina di Scienze Naturali residente in Padova
Palermo Acad. Atti	Atti della Reale Accademia di Scienze, Lettere e Belle Arti di Palermo
Palermo Circ. Mat. Rend.	Rendiconti del Circolo Matematico di Palermo
Palermo, Effemeridi	Effemeridi scientifiche e letterarie per la Sicilia; coi Lavori del R. Istituto d'Incoraggiamento per la Sicilia
Palermo, Giorn. Sci. Natur	Giornale di Scienze naturali ed economiche, pubblicato per Cura della Società di Scienze naturali ed economiche di Palermo
Palermo, Mem. Spettrosc Ital.	Memorie della Società degli Spettroscopisti Italiani
Palermo Oss. Bull. Meteorol.	Bullettino Meteorologico del Reale Osservatorio di Palermo
Palermo Oss. Ossvz Meteorol.	R. Osservatorio di Palermo. Stazioni di Valverde Osservazioni meteorologiche
Palomba, Raccolta	Raccolta di Lettere, etc., intonno alla Fisica ed alle Mathematiche
Palyamunkak	Palyamunkak. Termerzetlud (Prize Essays of the Hungarian Academy)
Pander, Beitr Naturk.	Beiträge zur Naturkunde aus den Ostseeprovinzen Russlands
Paper	Paper
Paper-Maker Brit. Trade J.	Paper Maker and British Trade Journal
Paper Makers' Monthly J.	Paper Makers' Monthly Journal
Paper Making	Paper Making
Paper Mill	Paper Mill and Woodpulp News
Papers Naval Archit.	Papers on Naval Architecture and other subjects connected with naval science
Paper Trade J.	Paper Trade Journal
Papier-Fabr.	Papier-Fabrikant, Der
Papier Ztg.	Papier Zeitung
Papierhandel	Der Papierhandel
Papilio	Papilio
Papir J.	Papir Journalen
Par. P.	Paraguay Patent
Para, Mus. Hist. Natur. Bol.	Boletim do Museu Paraense de Historia Natural e Ethnographia
Paris, Acad. Med. Bull.	Bulletin de l'Academie de Medecine

Paris, Acad. Med. Mem.	Memoires de l'Academie de Medecine
Paris, Acad. Sci. Compt. rend.	Comptes Rendus hebdomadaires des Seances de l'Academie des Sciences
Paris, Acad. Sci. Mem.	Memoires de l'Academie des Sciences de l'Institut de France
Paris, Ann. Cerc. Med.	Annales du Cercle Medical
Paris, Ann. Conserv.	Annales du Conservatoire des Arts et Metiers
Paris, Ann. Ecole Norm.	Annales scientifiques de l'Ecole Normale Supérieure
Paris, Ann. Ponts Chauss.	Annales des Ponts et Chaussées Memoires et documents relatifs a l'Art des Constructions et au Service de l'Ingenieur
Paris, Ann. Soc. Entom.	Annales de la Société Entomologique de France
Paris, Annaes Sci.	Annaes das Ciencias, etc., por humna Sociedade de Portuguezes residentes em Paris
Paris, Annu. Med. Chir. Hosp.	Annuaire medico chirurgical des Hopitaux, etc., de Paris
Paris, Annu. Soc. Met.	Annuaire de la Société Meteorologique de France
Paris, Anthropol. Soc. Bull.	Bulletin de la Société d'Anthropologie de Paris
Paris, Anthropol. Soc. Mem.	Memoires de la Société d'Anthropologie de Paris
Paris, Bull. Fac. Med.	Bulletins de la Faculté de Medecine de Paris et de la Société établie dans son sein
Paris, Bull. Soc. Aerost.	Bulletin de la Société Aerostatique et Meteorologique de France
Paris, Bull. Soc. Sci. Natur.	Bulletin de la Société des Sciences Naturelles de France
Paris, Bur. Long. Annu.	Annuaire pour l'An., publie par le Bureau des Longitudes
Paris, Caus. Sci.	Causeries Scientifiques de la Société Zoologique de France
Paris, Club Alpin Franc Annu.	Annuaire du Club Alpin Français
Paris, Com. Intl. Carte Ciel Bull.	Institut de France. Academie des Sciences Bulletin du Comité International Permanent pour l'Execution Photographique de la Carte du Ciel
Paris Congr. Bot. Act.	Actes du Congrès International de Botanique tenu a Paris in aout 1867
Paris Congr. Bot. Compt. rend.	.. Comptes Rendus .. Congrès International de Botanique et d'Horticulture
Paris, Congr. Med. Intl.	Congres Medical International de Paris, 1867
Paris, Ecole Norm. Ann.	Annales Scientifiques de l'Ecole Normale Supérieure, publies sous les auspices du Ministre de l'Instruction Publique
Paris, Ecole Poly. Corresp.	Correspondance sur l'Ecole Polytechnique, a l'usage des Eleves de cette Ecole
Paris, Ecole Poly. J.	Journal de l'Ecole Polytechnique publie par le Conseil d'Instruction de cet Etablissement
Paris, Ethnog. Soc. Compt. rend.	Comptes Rendus des Seances de la Société d'Ethnographie Americaine et Orientale
Paris, Hautes Etudes Bibl.	Bibliothèque de l'Ecole des Hautes Etudes. Section des Sciences Naturelles
Paris, Ingen. Civ. Mem.	Memoires et Compte Rendu des Travaux de la Société des Ingenieurs Civils (de France)
Paris, J. Bot.	Journal de Botanique, par une Société de Botanistes
Paris, J. Chir.	Journal de Chirurgie
Paris, Lab. Histol. Trav.	Ecole Pratique des Hautes Etudes. Laboratoire d'Histologie du College de France. Travaux
Paris, Mem. Acad. Med.	Memoires de l'Academie (Royale) de Medecine
Paris, Mem. Acad. Sci.	Memoires de l'Academie des Sciences
Paris, Mem. Inst.	Memoires de la Classe des Sciences mathematiques et physiques de l'Institut

Paris, Mem. Soc. Savants	Memoires des Sociétés Savants et Littéraires de la République Française
Paris, Mem. Savants Etrang.	Memoires presentes par divers Savants a l'Académie des Sciences de l'Institut de France
Paris, Mem. Soc. Ethnol.	Memoires de la Société Ethnologique
Paris, Mem. Soc. Fac. Med.	Memoires de la Société de la Faculté de Médecine
Paris, Mem. Soc. Linn.	Memoires de la Société Linneenne de Paris
Paris, Mem. Soc. Med.	Memoires de la Société de Médecine
Paris, Mem. Soc. Med. Observ.	Memoires de la Société Médicale d'Observation
Paris, Mus. Hist. Natr. Ann.	Annales du Museum d'Histoire Naturelle
Paris, Mus. Hist. Natur. Archiv.	Archives du Museum d'Histoire Naturelle
Paris, Mus. Hist. Natur. Bull.	Bulletin du Museum d'Histoire Naturelle
Paris, Mus. Hist. Natur. Cent.	Centenaire de la Fondation du Museum d'Histoire Naturelle
Paris, Mus. Hist. Natur. Mem.	Memoires du Museum d'Histoire Naturelle
Paris, Mus. Hist. Natur. Nouv. Ann.	Nouvelles Annales du Museum d'Histoire Naturelle
Paris, Mus. Hist. Natur. Nouv. Archiv.	Nouvelles Archives du Museum d'Histoire Naturelle
Paris Obs. Ann.	Annales de l'Observatoire de Paris
Paris, Obs. Montsouris Annu.	(Ville de Paris) Annuaire de l'Observatoire (municipal de Paris, dit Observatoire) de Montsouris ..
Paris, Poids Mes. Proc. Verb.	Comité International des Poids et Mesures. Procès-Verbaux des Séances
Paris, Poids Mes. Trav. Mem.	Travaux et Memoires du Bureau International des Poids et Mesures
Paris, Recueil Soc. Med. Observ.	Recueil des travaux de la Société Médicale d'Observation de Paris
Paris, Recueil. Trav. Soc. Med. Allemande	Recueil des Travaux lus a la Société Médicale Allemande de Paris
Paris, Soc. Acclim. Bull.	Bulletin de la Société Zoologique d'Acclimatation
Paris, Soc. Anat. Bull.	Bulletin de la Société Anatomique de Paris
Paris, Soc. Anthropol. Bull.	Bulletins de la Société d'Anthropologie de Paris
Paris, Soc. Anthropol. Mem.	Memoires de la Société d'Anthropologie de Paris
Paris, Soc. Biol. Mem.	Comptes Rendus des Séances et Memoires de la Société de Biologie
Paris, Soc. Chir. Bull.	Bulletin de la Société de Chirurgie de Paris
Paris, Soc. Chir. Mem.	Memoires de la Société de Chirurgie de Paris
Paris, Soc. Entom. Ann.	Annales de la Société Entomologique de France
Paris, Soc. Entom. Bull.	Bulletin de la Société Entomologique de France
Paris, Soc. Geogr. Bull.	Bulletin de la Société de Géographie
Paris, Soc. Geogr. Compt. rend.	Compte Rendu des Séances de la Société de Géographie et de la Commission Centrale
Paris, Soc. Hist. Natur. Mem.	Memoires de la Société d'Histoire Naturelle de Paris
Paris, Soc. Ing. Civ. Mem.	Memoires et Comptes Rendus des Travaux de la Société des Ingenieurs Civils
Paris Soc. Linn. Bull.	Bulletin mensuel de la Société Linneenne de Paris
Paris, Soc. Math. Bull.	Bulletin de la Société Mathématique de France
Paris, Soc. Med. Emul. Bull.	Bulletins de la Société Médicale d'Émulation
Paris, Soc. Med. Emul. Mem.	Memoires de la Société Médicale d'Émulation
Paris, Soc. Philom. Bull.	Bulletin des Sciences de la Société Philomathique de Paris

Paris, Soc. Philom. Mem. Cent.	Memoires publies par la Société Philomatique a l'occasion du Centenaire de sa Fondation, 1788-1888
Paris, Soc. Philom. Nouv. Bull.	Nouveau Bulletin des Sciences de la Société Philomatique de Paris
Paris, Soc. Philom. Proc. Verb.	Extraits des Procès-Verbaux des Seances de la Société Philomatique
Paris, Soc. Phys. Seances	Seances de la Société Française de Physique
Paris, Soc. Speleol. Mem.	Memoires de la Société de Speleologie
Paris Tow. Nauk Seisl. Pam.	Pamiętnik Towarzystwa Nauk Seislych w Paryżu
Paris, Trav. Soc. Amat.	Notice des Travaux de la Société des Amateurs des Sciences physiques et naturelles de Paris
Parlatore, Giorn. Bot.	Giornale Botanico Italiano
Parma, Giorn. Soc. Med. Chir.	Giornale della Società Medico-Chirurgica di Parma
Passau Ber. Nat. Ver.	.. Bericht des Naturhistorischen Vereins in Passau für .
Passau, Jahr. Naturhist. Ver.	Jahresbericht des Naturhistorischen Vereins
Pathol. Soc. Trans.	Transactions of the Pathological Society of London
Pavia Ist. Bot. Atti	Atti dell' Istituto Botanico dell' Università di Pavia, Seguito dell' Archivio Triennale del Laboratorio di Botanica Crittogamica
Pavia Lab. Crittog. Archiv.	Archivio del Laboratorio di Botanica Crittogamica presso la R. Università di Pavia
Peabody Acad. Mem.	Memoirs of the Peabody Academy of Science
Peabody Acad. Report	Sixth Annual Report of the Trustees of the Peabody Academy of Science
Penn. Univ. Publ.	Publications of the University of Pennsylvania
Penzance Soc. Trans.	Transactions of the Natural History and Antiquarian Society of Penzance
Perf. Essent. Oil Rec.	Perfumery and Essential Oil Record
Perthsh. Soc. Sci. Trans. & Proc.	Transactions and Proceedings of the Perthshire Society of Natural Science
Peru P.	Peruvian Patent
Pet. Nouv. Entom.	Petites Nouvelles Entomologiques
Petermann, Mitth.	Dr. A. Petermann's Mittheilungen aus Justus Perthes' Geographischer Anstalt
Peters, Zts.	Zeitschrift für populäre Mittheilungen aus dem Gebiete der Medicin, Chirurgie, und Pharmacie, in Verbindung mit einem Vereine von Aerzten und Pharmaceuten der Herzogthümer Schleswig und Holstein
Petroleum	Petroleum
Petroleum Gaz.	Petroleum Gazette
Petroleum Rev.	Petroleum Review
Pflüger, Archiv. Physiol.	Archiv. für die gesammte Physiologie des Menschen und der Thiere
Pharm.	Pharmakologie
Pharm.-Ber. Deut.-Arznbuch.	Pharmakopoe-Bericht. Die vegetabilischen Drogen des Deutschen Arzneibuches, 5te Ausgabe, Caesar & Loretz, Halle
Pharm. Centr.	Pharmaceutisches Central-Blatt
Pharm. Centralh.	Pharmaceutische Centralhalle für Deutschland
Pharm. Era	Pharmaceutical Era
Pharm. J.	The Pharmaceutical Journal (and Transactions)
Pharm. Post	Pharmazeutische Post
Pharm. Weekblad	Pharmazeutische Weekblad
Pharm. Ztg.	Pharmazeutische Zeitung

Pharm. Zts.	Pharmazeutische Zeitschrift
Pharm. Zts. Russland	Pharmaceutische Zeitschrift für Russland
Phil. Mag.	Philosophical Magazine
Phil. Stud.	Philosophische Studien
Phil. Trans.	Philosophical Transactions of the Royal Society of London
Phila. Acad. Natur. Sci. J.	Journal of the Academy of Natural Sciences of Philadelphia
Phila. Acad. Natur. Sci. Proc.	Proceedings of the Academy of Natural Sciences of Philadelphia
Phila. Amer. Entom. Soc.	See Amer. Entom. Soc.
Phila. Coll. Pharm. Journ.	Journal of the Philadelphia College of Pharmacy
Phila. Eng. Club	Proceedings of the Engineer's Club of Philadelphia
Phila. Entom. News	Entomological News (and Proceedings of the Entomological Section of the Academy of Natural Sciences of Philadelphia)
Phila. Entom. Soc. Proc.	Proceedings of the Entomological Society of Philadelphia
Phila. Med. Mus.	Philadelphia Medical Museum
Phila. Med. Phys. J.	The Philadelphia Medical and Physical Journal
Phila. Phot.	The Philadelphia Photographer
Philippine J. Sci.	Philippine Journal of Science
Phot. Archiv	Photographisches Archiv
Phot. Bull.	Anthony's Photographic Bulletin
Phot. Chronik.	Photographische Chronik und allgemeine Photographen-Zeitung
Phot. J.	Wilhelm Horn's Photographische Journal
Phot. Corr. (Korr.)	Photographische Korrespondenz
Phot. Mag.	Photographisches Magazine
Phot. Mitth.	Photographische Mittheilungen
Phot. Monats.	Photographische Monatshefte
Phot. News	Photographic News
Phot. Rundsch.	Photographische Rundschau und Photographisches Centralblatt
Phot. Soc. J.	Journal of the Photographic Society of London
Phot. Soc. Trans.	Trans. of the Photographic Society of London
Phot. Times	The Photographic Times
Phot. Wochenbl.	Photographisches Wochenblatt
Phot. World	The Photographic World
Phot. Centr.	Photographisches Centralblatt
Phot. Ztg.	Deutsche Photographen-Zeitung
Phys. Rev.	Physical Review
Physikal.-Chem. Zentr.	Physikalisch-chemisches Zentralblatt
Physikal. Meddel.	Physikalske Meddelelser
Physikal. Zts.	Physikalische Zeitschrift
Physiol. Russe	Le Physiologiste Russe
Physiol. Soc. Proc.	See J. Physiol.
Phytologist	The Phytologist: a popular Botanical Miscellany
Pisa, Ann. Scuola Norm.	Annali della R. Scuola Normale Superiore di Pisa. Scienze Fisiche e Matematiche
Pisa, Ann. Univ. Tosc. Sci. Cosm.	Annali della Università Toscana. Scienze Cosmologiche
Pisa, Miscell. Med. Chir.	Miscellanea medico-chirurgico-farmaceutiche raccolte in Pisa
Pisa, Nuov. Giorn.	Nuovo Giornale de' Letterati
Pisa Soc. Sci. Proc.	Atti della Società Toscana di Scienze Naturali residente in Pisa

Pisa Soc. Tosc. Atti (Mem.)	Atti della Società Toscana di Scienze Naturali residente in Pisa. Memorie
Pisa Soc. Tosc. Atti (Proc. Verb.)	Atti della Società Toscana di Scienze Naturali residente in Pisa. Processi Verball
Pistoja, Atti Accad.	Atti della R. Accademia Pistoiese di Scienze, Lettere, ed Arti; Memorie di Matematica e Fisica
Plant World	Plant World, The
Plata Mus. Anales	Anales del Museo de La Plata. Materiales para la Historia física y moral del Continente Sud-Americano
Plata Mus. Revista	Revista del Museo de La Plata
Plön Biol. Sta. Forschungsber.	Forschungsberichte aus der Biologischen Station zu Plön
Plymouth Inst. Trans.	Annual Reports and Transactions of the Plymouth Institution and Devon and Cornwall Natural History Society
Pogg. Ann.	Poggendorff's Annalen der Physik und Chemie
Pogg. Ann. Beibl.	Poggendorff's Annalen der Physik und Chemie Beiblätter
Poligrafo	Il Poligrafo: Giornale di Scienze, Lettere, ed Arti
Polit.	Il Politecnico
Pollichia, Jahr.	Jahresbericht der Pollichia, eines naturwissenschaftlichen Vereins der Baierschen Pfalz (der Rheinpfalz)
Polsk. Tow. Przyrod. Kopenika	See Kosmos (Lwow)
Poly. Centr.	Polytechnisches Centralblatt
Poly. Centralh.	Polytechnische Centralhalle
Poly. Mitth.	Polytechnische Mittheilungen
Poly. Notiz.	Polytechnisches Notizblatt
Polygraph. Centr.	Polygraphisches Centralblatt
Pommer, Zts.	Schweizerische Zeitschrift für Natur- und Heilkunde
Pop. Mag. Anthropol.	The Popular Magazine of Anthropology
Pop. Sci. Mon.	Popular Science Monthly
Popular Sci. Rev.	The Popular Science Review: a Quarterly Miscellany of entertaining and instructive articles on Scientific subjects
Pontif. Univ. Gregor.	Pontificia Università Gregoriana. Continuazione del Bullettino Meteorologico dell' Osservatorio del Collegio Romano
Port. P.	Portuguese Patent
Portland, Soc. Natur. Hist. Proc.	Proceedings of the Portland Society of Natural History
Porto, Ann. Soc. Lit.	Annaes da Sociedade Lit. Portuense
Porto Soc. Instruc. Rev.	Revista da Sociedade de Instrucao do Porto
Potsdam Astrophys. Obs. Publ.	Publicationen des Astrophysikalischen Observatoriums zu Potsdam
Pottery Gaz.	Pottery Gazette
Pottery and Glass	Pottery and Glass
Power	Power
Prace Mat.-Fiz.	Prace Matematyczno-Fizyczne. (Mathematical and Physical Papers)
Pract. Drug.	Practical Druggist and Pharmaceutical Review of Reviews, New York
Pract. Mag.	The Practical Magazine (London)
Pract. Mechan. J.	The Practical Mechanics Journal
Practitioner	The Practitioner
Prag, Abh.	Pojednani Kral. Ceske Společnosti Nauk. Abhandlungen der Königl. Böhmischen Gesellschaft der Wissenschaften

Prag, Ceske Ak. Fr. Jos. -Pam.	Pomátník na oslavu padesátiletého panovnického jubilea Jeho Velicestva Cisare a Krále Františka Josefa I. Vydala Česká Akademie Cisare Františka Josefa pro Vědy, Slovesnost a Umění. (Memoirs in celebration of the fifty years Jubilee of the reign of H. I. & R. M. Francis Joseph I. Published by the Bohemian Imperial Francis Joseph Academy of Science, Literature and Art)
Prag, Ceske Akad. Fr. Jos. Rozpr. (Trida 2)	Rozpravy České Akademie Cisare Františka Josefa pro Vědy, Slovesnost a Umění v Praze. (Trida II.) (Transactions of the Bohemian Imperial Francis Joseph Academy of Science, Literature and Art in Prague, Class II)
Prag, Fr. Jos. Acad. Sci. Bull.	Académie des Sciences de l'Empereur François Joseph I. Bulletin International
Prag, Jahr. Böhm. Mus.	Jahrbücher des Böhmischen Museums für Natur- und Länderkunde
Prag, Jahr. Realschule	Jahresbericht der k. k. Böhmischen Ober-Realschule zu Prag
Prag, Lotos Abh.	Abhandlungen des Deutschen Naturwissenschaftlich-Medicinischen Vereines für Böhmen "Lotos"
Prag, Monatsch. Mus.	Monatsschrift der Gesellschaft des vaterländischen Museums in Böhmen
Prag, Syl. k.	Zprávy o Zasedání (Vestník) Kralovské České Společnosti Nauk. Trida Mathematicko-Přirodovědecká. Sitzungsberichte der Königl. Böhmischen Gesellschaft der Wissenschaften. Mathematisch-Naturwissenschaftliche Classe
Prag Sternw. Magn. M. reorol. Beob.	Magnetische und Meteorologische Beobachtungen an der k. k. Sternwarte zu Prag
Prag, Verh.	Verhandlungen der Gesellschaft des vaterländischen Museums in Böhmen
Prag, Vierteljahrschr.	Vierteljahrsschrift für die praktische Heilkunde
Pressburg, Corresp. Blatt	Correspondenzblatt des Vereines für Naturkunde zu Pressburg
Pressburg, Verh.	Verhandlungen des Vereines für Naturkunde zu Pressburg
Presse Sci.	Presse Scientifique des Deux Mondes
Preuss. Bot. Ver. Sitzber.	See Königsberg Schriften
Preuss. Geod. Inst. Publ.	Publication des Königl. Preuss. Geodatischen Instituts
Preuss. Geod. Inst. Veröff.	Veröffentlichung des Königl. Preussischen Geodatischen Instituts
Preuss. Landes-Oekon.-Kol- leg. Archiv.	See Landw. Jbuch
Pribram Bergakad.	See Wien, Berg- u. Hüttenm. Jbuch
Princeton Mus. Contr.	Contributions from the (E. M.) Museum of Geology and Archaeology of Princeton College
Pringsheim, Jahr. Wiss. Bot.	Jahrbücher für Wissenschaftliche Botanik
Print. Reg.	Printers' Register
Prog. agric. viti.	Progres agricole et viticole
Proc. Amer. Acad.	Proceedings of the American Academy of Arts Sciences
Proc. Amer. Inst. Elec. Eng.	Proceedings of the American Institute of Electrical Engineers
Proc. Amer. Micro. Soc.	Proceedings of the American Microscopical Society
Proc. Amer. Pharm. Assoc.	Proceedings of the American Pharmaceutical Association
Proc. Amer. Phil. Soc.	Proceedings of the American Philosophical Society

Proc. Amer. Soc. Civil Eng.	Proceedings of the American Society of Civil Engineers
Proc. Amer. Soc. Micro.	Proceedings of the American Society of Microscopists
Proc. Amer. Soc. Test. Mat.	Proceedings of the American Society for Testing Materials
Proc. Amer. Water Works Assoc.	Proceedings of American Water Works Association
Proc. Assoc. Off. Agric. Chem.	Proceedings of the Association of Official Agricultural Chemists, Washington
Proc. Austral. Inst. Min. Eng.	Proceedings Australian Institute of Mining Engineers
Proc. Cambr. Phil. Soc.	Proceedings of the Cambridge Philosophical Society
Proc. Chem. Soc.	Proceedings of the Chemical Society (London)
Proc. Eng. Soc. Western Penn.	Proceedings of the Engineers' Society of Western Pennsylvania
Proc. Inst. Civil Eng.	Proceedings of the Institution of Civil Engineers
Proc. Inst. Mech. Eng.	Proceedings of the Institution of Mechanical Engineers
Proc. Natl. Wholesale Drug Assoc.	Proceedings of the National Wholesale Druggists' Association
Proc. Physiol. Soc.	Proceedings of the Physiological Society
Proc. Roy. Soc. Edinb.	Proceedings of the Royal Society of Edinburgh
Proc. Roy. Soc. London	Proceedings of the Royal Society of London
Proc. Roy. Soc. Med.	Proceedings of the Royal Society of Medicine
Proc. Soc. Exp. Biol. Med.	Proceedings of the Society for Experimental Biology and Medicine
Proc. U. S. Naval Inst.	Proceedings of U. S. Naval Institute
Progres. Med.	Le Progres Medical. Journal de Medecine, de Chirurgie et de Pharmacie
Progressive Age	Progressive Age
Propogation ind.	La Propagation industrielle. Revue mensuelle illustree des inventions, machines, appareils et procedes de la France, etc.
Prov. Med. Assoc. J.	Journal of the Provincial Medical Association
Prov. Med. Surg. Assoc. Trans.	Transactions of the Provincial Medical and Surgical Association
Psyche	Psyche. Organ of the Cambridge Entomological Club
Psychol. Med. J.	Journal of Psychological Medicine
Publ. Carnegie Inst.	Publications of the Carnegie Institution of Washington
Publ. ind.	Publication industrielle des machines par Armeingaud
Public Analysts Proc.	Proceedings of the Society of Public Analysts
Public Health	Public Health
Pulp Paper Mag. Can.	Pulp and Paper Magazine of Canada
Pure Products	Pure Products. Scientific Station for Pure Products, New-York
Puy, Soc. Agric. Ann.	Annales de la Société d'Agriculture, Sciences, etc., du Puy
Quart. J. Chem. Soc.	Quarterly Journal of the Chemical Society
Quart. J. Dent. Sci.	Quarterly Journal of Dental Science
Quart. J. exp. Physiol.	Quarterly Journal of experimental Physiology
Quart. J. Geol. Soc.	Quarterly Journal of the Geological Society
Quart. J. Math.	The Quarterly Journal of Pure and Applied Mathematics
Quart. J. Micro. Sci.	Quarterly Journal of Microscopical Science
Quart. J. Micro. Soc.	Quarterly Journal of the Microscopical Society
Quart. J. Sci.	The Journal of Science and the Arts. Continued as the Quarterly Journal of Science, Literature, and Arts

Quebec, Lit. Hist. Soc. Trans.	Transactions of the Literary and Historical Society of Quebec
Queensl. P.	Queensland Patent
Queensl. Annu. Rep. Brit. N. Guinea	Annual Report on British New Guinea
Queensl. Natur. Hist. Soc. Trans.	Transactions of the Natural History Society of Queensland
Queensl. Mus. Ann.	Annals of the Queensland Museum
Queensl. Roy. Soc. Proc.	The Proceedings of the Royal Society of Queensland
Quekett Micro. Club J.	Journal of the Quekett Microscopical Club
Quetelet, Corresp. Math. Radium	Correspondance Mathematique et Physique Radium, Le
Railroad Eng. J.	The Railroad and Engineering Journal. The American Railroad Journal and Van Nostrand's Engineering Magazine have been consolidated in this publication
Ranuzzi, Annuario Geogr.	Annuario geografico Italiano
Rassr. minerar.	Rassegna mineraria metallurgica e chimica
Rauch Staub	Rauch und Staub
Rayer, Archiv.	Archives de Medecine comparee
Reclam, Kosmos	Kosmos: Zeitschrift für angewandte Naturwissenschaften
Records Min.	Records of Mining
Recueil Math. (Moscou)	Recueil Mathematique. Publie par la Société Mathematique de Moscou
Rec. Trav. Chim. Pays-Bas	Recueil des Travaux Chimiques des Pays-Bas (et de la Belgique)
Rec. Zool. Suisse	Recueil Zoologique Suisse, comprenant l'Embryologie, l'Anatomie et l'Histologie comparees, la Physiologie, l'Ethologie, la Classification des Animaux vivants et fossiles
Regensburg Bot. Ges.	See Flora
Regensburg Bot. Ges. Denkschr.	Denkschriften der Königlich (Bayerischen) Botanischen Gesellschaft zu Regensburg
Regensburg, Bot. Ztg.	Botanische Zeitung; herausg. von der k. Baier. Botanischen Gesellschaft zu Regensburg
Regensburg, Korresp. Blatt.	Korrespondenz-Blatt des Zoologisch-mineralogischen Vereins in Regensburg
Reichert, Archiv.	Archiv für Anatomie, Physiologie, und wissenschaftliche Medizin
Reil, Archiv.	Archiv. für die Physiologie
Reimann's Ztg.	Reimann's Färberei-Zeitung
Reims, Seances Acad.	Seances et Travaux de l'Academie de Reims
Rend. soc. chim. ital. Rep.	Rendiconti della società chimica italiana Repertorium, Repertoire Repertory
Rep. Anal. Chem.	Repertorium der analytischen Chemie... Organ des Vereins Analytischer Chemiker
Rep. Anat. Physiol.	Repertoire generale d'Anatomie et de Physiologie pathologiques et de Clinique chirurgicale
Rep. Chim.	Repertoire generale de Chimie (1901-), G. Jaubert
Rep. Chim. pure (appl)	Repertoire de Chimie pure (et appliquée) (Société Chimique de Paris, 1859-1864)
Rep. Pat. Inv.	The Repertory of Patent Inventions and other discoveries and improvements in arts, manufactures and agriculture
Rep. Math.	Repertorium der literarischen Arbeiten aus dem Gebiete der reinen und angewandten Mathematik

Rep. Meteorol.	Repertorium fur Meteorologie, herausgegeben von der Kaiserlichen Akademie der Wissenschaften
Rep. Pharm.	Repertorium fur die Pharmacie
Rep. Phys.	Repertorium der Physik
Rep. Phys.-Tech.	See Carl
Rep. Chem. Lab. Amer. Med. Ass.	Reports of the Chemical Laboratory of the American Medical Association, Chicago
Rep. Council Pharm. Chem.	Reports of the Council of Pharmacy and Chemistry, American Medical Association, Chicago
Rep. H. M. Insp. Expl.	Report of His Majesty's Inspectors of Explosives
Rep. N. Y. Bd. Pharm.	Report of the New York State Board of Pharmacy
Rev. Anthropol.	Revue d'Anthropologie
Rev. Artill.	Revue d'Artillerie
Rev. Biol. Nord France	Revue Biologique du Nord de la France
Rev. Bot.	Rev. de Botanique. Bulletin mensuel de la Société Française de Botanique
Rev. Bryol.	Revue Bryologique. Bulletin bimestriel consacré à l'Etude des Mousses et des Hépatiques
Rev. chim. ind.	Revue de chimie industrielle et la revue de physique et de chimie
Rev. Cours. Sci.	Revue des Cours Scientifiques de la France et de l'Etranger
Rev. deux Mondes	Revue des deux Mondes (Paris)
Rev. Entom.	Revue d'Entomologie publiée par la Société Française d'Entomologie
Rev. gen. Bot.	Revue generale de Botanique
Rev. gen. chim.	Revue generale de chimie pure et appliquée (G. Jaubert)
Rev. gen. lait	Revue generale du lait
Rev. gen. mat. color.	Revue generale de matieres colorantes et de leurs applications aux textiles
Rev. gen. sci.	Revue generale des sciences pure et appliquée
Rev. Hortic.	Revue Horticole, Journal d'Horticulture pratique
Rev. hyg. pol. sanitaire	Revue d'hygiene et de police sanitaire
Rev. Ind.	Revue Industrielle
Rev. Ind. Chim.	Revue des industries chimiques et agricoles
Rev. Mag. Zool.	Revue et Magazin de Zoologie, pure et appliquée
Rev. Maritime Colon	Revue Maritime (et Coloniale)
Rev. Med. Chir.	Revue Medico-Chirurgicale de Paris
Rev. Med. Franc. Etrang.	Revue Medicale Française et Etrangere
Rev. Met.	Revue de Metallurgie
Rev. Mycol.	Revue Mycologique. Recueil trimestriel illustre consacré à l'Etude des Champignons
Rev. phot.	Revue de photographie
Rev. Quest. Sci.	Revue des Questions scientifiques publiée par la Société Scientifique de Bruxelles
Rev. Sci.	(la) Revue Scientifique (de la France et de l'Etranger. Revue des Cours Scientifiques)
Rev. Sci. Natur.	Revue des Sciences Naturelles
Rev. Soc. Hyg. Aliment.	Revue de la société scientifique d'Hygiene alimentaire et de l'alimentation rationnelle de l'homme
Rev. Suisse Zool.	Revue Suisse de Zoologie (et) Annales (de la Société Zoologique Suisse et) du Musée d'Histoire Naturelle de Geneve
Rev. Univ. Mines	Revue universelle des Mines, de la Metallurgie, des Travaux Publics, des Sciences, et des Arts Appliquées à l'Industrie. Annuaire de l'Association des Ingenieurs sortis de l'Ecole de Liege

Rev. Vit.	Revue Viticulture
Rev. Zool.	Revue Zoologique, par la Société Cuvierienne
Revista Brazil.	Revista Brasileira, Journal de Ciências, Letras, e Artes
Revista, Chim. pure app.	Revista de chimica pure applicada
Revista ind. agric. Tucuman	Revista industrial y agrocola de Tucuman
Revista Ligure	Revista Ligure, giornale di Lettere, Scienze, etc.
Revista Med. Chile	Revista medica de Chile
Revista Med. Cirug. Habana	Revista de Medicina y Cirugia, Habana
Revista Minera	Revista Minera, periodico cientifico e industrial
Revista real acad. cien. Madrid	Revista de la real academia de ciencias de Madrid
Revista Telegr.	Revista de Telegrafos
Revista Trim. Microgr.	Revista Trimestral Micrografica. Organó del Laboratorio Histológico de la Facultad de Medicina de Madrid
Rhea	Rhea, Zeitschrift für die gesammte Ornithologie
Rheinische Monatsschr.	Rheinische Monatsschrift für praktische Aerzte
Rheinl. Westphal.	See Bonn.
Rheinl. Westphal. Corresp.	Correspondenzblatt des Naturhistorischen Vereins der Preussischen Rheinlande und Westphalens
Rheinl. Westphal. Verh.	Verhandlungen des Naturhistorischen Vereins der Preussischen Rheinlande und Westphalens
Rheinl. Westphal. Sitzber.	Sitzungsbericht des Naturhistorischen Vereins der Preussischen Rheinlande und Westphalens
Rheinpfalz Pollichia Festschr.	Festschrift zur Fünfzigjährigen Stiftungsfeier der Pollichia, Naturwissenschaftlichen Vereines der Rheinpfalz
Rheinpfalz Pollichia Jahrb.	Jahresbericht der Pollichia, eines Naturwissenschaftlichen Vereins der Rheinpfalz
Rheinpfalz Pollichia Mitth.	Mittheilungen der Pollichia, eines Naturwissenschaftlichen Vereins der Rheinpfalz
Rheinpfalz Pollichia Sep. Ausg.	.. Separat-Ausgabe der Pollichia, des Naturwissenschaftlichen Vereines der Pfalz
Rhodora	Rhodora. Journal of the New England Botanical Club
Riga, Arb. Naturf. Ver.	Arbeiten des Naturforschenden Vereins in Riga
Riga, Corresp. Blatt. Naturf. Ver.	Correspondenz-Blatt des Naturforschenden Vereins in Riga
Rio de Janeiro Archiv. Palestr.	Archivos da Palestra Scientifica do Rio de Janeiro
Rio de Janeiro Mus. Nac. Archiv.	Archivos do Museu Nacional do Rio de Janeiro
Rio de Janeiro Mus. Nac. Revista	Revista do Museu Nacional do Rio de Janeiro. (Seguimento aos Archivos do Museu Nacional)
Rio de Janeiro Obs. Annaes	(Annaes do Imperial Observatorio do Rio de Janeiro)
Rio de Janeiro Obs. Bol.	Boletim mensal do Observatorio do Rio de Janeiro
Rio de Janeiro Obs. Revista	Revista do Observatorio. Publicacao mensal do Imperial Observatorio do Rio de Janeiro
Rio, Revista	Revista tri mensal de Historia e Geographia: Journal do Instituto Historico e Geographico Brasileiro
Rio, Soc. Vell. Trabal.	Trabalhos da Sociedade Vellosiana (Bibliotheca Guanabarensis)
Riv.	Rivista
Riv. Bolognese	Rivista Bolognese di Scienze e Lettere
Riv. Geogr. Ital.	Rivista Geografica Italiana (e Bollettino della Società di Studi Geografici e Coloniali in Firenze)

Riv. Ital. Sci. Natur. Napoli	Rivista Italiana di Scienze Naturali e loro Applicazioni pubblicata per cura degli Aspiranti Naturalisti
Riv. Ital. Sci. Natur. Siena	Rivista Italiana di Scienze Naturali e Bollettino del Naturalista Collettore, Allevatore, Coltivatore
Riv. Mat.	Rivista di Matematica
Riv. Mineral. Crist	Rivista di Mineralogia e Cristallografia Italiana
Riv. Patol. Veg	Rivista di Patologia Vegetale
Riv. Sci.-Ind.	Rivista Scientifico-Industriale delle principali Scoperte ed Invenzioni fatte nelle Scienze e nelle Industrie
Riv. Sper. di Freniatria	Rivista Sperimentale di Freniatria e di Medicina legale...
Riv. Vit. Ital.	Rivista di Viticoltura ed Enologia Italiana
Robin, J. Anat.	Journal de l'Anatomie et de la Physiologie normales et pathologiques de l'homme et des animaux
Rochelle	See under Charente-Inf
Rochester Acad. Sci. Proc.	Proceedings of the Rochester New York Academy of Science
Rochester Trans. Elec. Med. Assoc.	Transactions of the National Electric Medical Association at its Third Meeting, at Rochester, U. S.
Rock Products	Rock Products
Rohr, Notizen	Notizen aus dem Gebiete der praktischen Pharmacie
Rollett	See Graz.
Roma	See Congr. Med. Int. Atti, 1894
Roma, Atti Nuovi Lincei	Atti dell' Accademia Pontificia dei Nuovi Lincei
Roma, Atti Reale Accad.	Atti della Reale Accademia dei Lincei
Roma, Corrisp. Sci.	Corrispondenza Scientifica in Roma per lo avanzamento delle Scienze, etc
Roma Ist. Bot. Annuario	Annuario del R. Istituto Botanico di Roma
Roma Lab. Anat. Norm. Ric.	Ricerche fatte nel Laboratorio di Anatomia Normale della R. Università di Roma
Roma, Nuovi Lincei Mem.	Memorie della Pontificia Accademia dei Nuovi Lincei
Roma, Oss. Coll. Rom. Mem.	Memorie del R. Osservatorio del Collegio Romano
Roma, R. Accad. Lincei (Roma), Soc. Ital. Mem.	Atti della R. Accademia dei Lincei Memorie di Matematica e di Fisica della Società Italiana delle Scienze
Roma, Soc. Studi Zool. Boll.	Bollettino della Società Romana per gli Studi Zoologici
Roma, Specola Vaticana Pubbl.	Pubblicazioni della Specola Vaticana
Roma, Uff. Centr. Meteorol. Ann.	Annali dell' Ufficio Centrale di Meteorologia Italiana
Romer, Archiv Bot.	Archiv für die Botanik
Röser Wunderlich, Archiv	Archiv für physiologische Heilkunde. Continued as the Archiv d. Heilk.
Rotterdam Nieuwe Verh.	Nieuwe Verhandelingen van het Batavisch Genootschap der Profondcrvmdenike Wysbegeerte Rotterdam
Rouen, Bull. Soc. Émul.	Bulletins (des travaux) de la Société Libre d'Émulation de Rouen
Rouen, Soc. Sci. Bull.	Bulletin de la Société des Amis des Sciences Naturelles de Rouen
Rouen, Trav. Acad.	Precis analytique des Travaux de l' Academie des Sciences, Belles-Lettres, et Arts de Rouen
Roumania Inst. Meteorol. Ann.	Annales de l'Institut Meteorologique de Roumanie Analele Institutului Meteorologic al Romaniei
Roy. Engin. Papers	Papers on subjects connected with the duties of the Corps of Royal Engineers
Roy. Inst. J.	Journal of the Royal Institution of Great Britain

Roy. Inst. Proc.	Notices of the Proceedings at the Meetings of the Members of the Royal Institution of Great Britain, with Abstracts of the Discourses delivered at the Evening Meetings
Roy. School Naval Archit. Ann.	The annual of the Royal School of Naval Architecture and Marine Engineering
Roy. Soc. Proc.	Abstracts of the Papers printed in the Philosophical Transactions of the Royal Society of London, from 1800 to 1854 inclusive. Continued as the Proceedings of the Royal Society of London
Rugby, Natur. Hist. Soc. Reports	Reports of the Rugby School Natural History Society
Russ. Annu. Geol. Mineral.	Russian Annual of Geology and Mineralogy
Russ. Annuaire Mines	Annuaire du Journal des Mines de Russie
Russ. Chem. Soc. J.	Journal of the Russian Chemical Society
Russ. Geogr. Ges. Denkschr.	Denkschriften der Russischen Geographischen Gesellschaft zu St. Petersburg
Russ. J. exp. Landw.	Russisches Journal für experimentelle Landwirtschaft
Russ. Jahr. Pharm.	Russisches Jahrbuch der Pharmacie
Russ. P.	Russian Patent
Russ. Pharm. Zts.	Pharmaceutische Zeitschrift für Russland
Russ. Phys. Chem. Soc. J.	Journal of the Russian Physico-Chemical Society of the Imperial University of St. Petersburg
Rust. Mag.	Magazin für die gesammte Heilkunde, etc.
S. Africa Chem. Metall. Soc.	The Journal of the Chemical and Metallurgical Society of South Africa
S. Africa Chem. Metall. Soc. Proc.	The Proceedings of the Chemical and Metallurgical Society of South Africa
S. Africa. Mus. Ann.	Annals of the South African Museum
S. Africa. Phil. Soc. Trans.	The Transactions of the South African Philosophical Society
S. Austral. P.	South Australian Patent
S. Austral. Roy. Soc. Mem.	Memoirs of the Royal Society of South Australia
S. Austral. Roy. Soc. Trans.	Transactions and Proceedings and Report of the Royal Society of South Australia
S. C. Med. Assoc. Trans.	Transactions of the South Carolina Medical Association
S. London Entom. Natur. Hist. Soc. Proc.	(Abstract of) Proceedings of the South London Entomological and Natural History Society
S. Wales Inst. Civ. Engin. Proc.	Proceedings of the South Wales Institute of Civil Engineers
S. Wales Roy. Inst. Report	The annual report of the Council of the Royal Institution of South Wales, with Appendix of Original Papers on Scientific Subjects
Sächs. Ingen. Ver. Mitth.	Mittheilungen des Sächsischen Ingenieur-Vereins; herausg. v. d. Verwaltungsrathe des Vereins
Sächs. Meteorol. Inst. Abh.	Abhandlungen des Königl. Sächs. Meteorologischen Institutes
Sachs. Thüring. Naturwiss. Ver.	See Zts. Naturwiss.
Salem	See Essex Institute
San Fernando Obs. Marina An.	Anales del Instituto y Observatorio de Marina de San Fernando
Sanitary Record	Sanitary Record and Journal of Municipal Engineering, The
Santiago Chile, Univ. Anales	(Republica de Chile.) Anales de la Universidad
Sao Paulo, Rev. Mus. Paulista	Revista do Museu Paulista

Saone-et-Loire Soc. Sci. Bull.	Bulletins de la Société des Sciences Naturelles de Saone-et-Loire
Saone-et-Loire Soc. Sci. Mem.	Memoires de la Société des Sciences Naturelle de Saone-et-Loire
Sarthe, Bull. Soc. Agric.	Bulletin de la Société d'Agriculture, Sciences, etc., de la Sarthe
Savoie Acad. Mem.	Memoires de l'Academie des Sciences, Belles-Lettres et Arts de Savoie
Savoie Soc. Hist. Natur. Bull.	Bulletins de la Société d'Histoire Naturelle de Savoie
Savoie Soc. Hist. Natur. (Compt. rend.)	Société d'Histoire Naturelle de Savoie a Chambéry
Schaffhausen	See Schweizer. Entom. Gesell.
Scheik. Onderz.	See Utrecht. Scheik. Onderzoek
Schemnitz Bergakad.	See Wien, Berg- u. Hüttenm. Jahr.
Scherer, J. Chem.	Allgemeines Journal der Chemie
Schlesw.-Holst. Naturwiss. Ver. Schr.	Schriften des Naturwissenschaftlichen Vereins für Schleswig-Holstein
Schlömilch, Zts.	Zeitschrift für Mathematik und Physik
Schneider, Ann. Staatsarz-neik.	Annalen der gessamnten Staatsarzneikunde
School Mines Quart.	School of Mines, Quarterly, The
School of Mines, Records	Records of the School of Mines
Schrader, J. Bot.	Journal für die Botanik
Schröder, Berig. Zeevaart.	Berigten en Verhandelngen over eenige onderwerpen des Zeevaarts
Schröder, Verh. Zeevaart.	Verhandelngen en Berigten over eenige onderwerpen der Zeevaart-Kunde
Schuh Ind.	Schuh Industrie
Schumacher, Jahr.	Jahrbuch, (H. C. Schumacher, (1836-28))
Schwäb. Ges. Denkschr.	Denkschriften der Schwäbischen Gesellschaft der Aerzte und Naturforscher
Schwalbe	Ornithologische Section der k. k. Zoologisch-Botanischen Gesellschaft in Wien Die Schwalbe. Berichte des Comites für Ornithologische Beobachtungs-Stationen in Oesterreich
Schweigger, J. (Schw. J.)	Journal für Chemie und Physik
Schweiz. Alpenclub Jahr.	Jahrbuch des Schweizer Alpenclub
Schweiz. Bot. Ges. Ber.	Berichte der Schweizerischen Botanischen Gesellschaft
Schweiz. Entom. Ges. Mitth.	Mittheilungen der Schweizerischen Entomologischen Gesellschaft
Schweiz. Ges. Neue Denkschr.	Neue Denkschriften der allgemeinen Schweizerischen Gesellschaft für die gesammten Naturwissenschaften
Schweiz. Ges. Verh.	Verhandlungen der Schweizerischen Gesellschaft für die gesammten Naturwissenschaften
Schweiz. Monatsschr.	Schweizerische Monatsschrift für praktische Medizin
Schweiz. Naturf. Ges.	See Beitr. Kryptog. Schweiz.
Schweizer. Naturf. Ges. Verh.	Verhandlungen der Schweizerischen Naturforschenden Gesellschaft
Schweiz. Phot.-Ver.	See Wien, Phot. Correspond.
Schweiz. Poly. Zts.	Schweizerische polytechnische Zeitschrift. Unter Mitwirkung des Schweizerischen Polytechnikums, etc.
Schweiz. Wochenschr.	Schweizerisch Wochenschrift für Chemie und Pharmacie
Schweiz. Zts. Heilk. Sci.	Schweizerische Zeitschrift für Heilkunde
Sci. Abst.	Science
Sci. Amer.	Science Abstracts. Physics and Electrical Engineering
	Scientific American

Sci. Amer. Suppl.	Scientific American Supplement
Sci. Can.	Scientific Canadian
Sci. Ind. *Bull. Roure-Bertrand Fils	Scientific et Industrial Bulletin Roure-Bertrand Fils
Sci. Proc. Roy. Dublin Soc.	Scientific Proceedings of the Royal Dublin Society
Sci. Rev.	The Scientific Review and Journal of the Inventors Institute
Sci. Trans. Roy. Dublin Soc.	Scientific Transactions of the Royal Dublin Society
Scienz. Ital. Congr.	Nuovo Congresso degli Scienziati Italiani in Venezia; porzione geologica
Sclater, Ibis	The Ibis, a Magazine of General Ornithology
Scott. Arbor. Soc. Trans.	Transactions of the Scottish Arboricultural Society
Scott. Geogr. Mag.	The Scottish Geographical Magazine
Scott. Meteorol. Soc. J.	Journal of the Scottish Meteorological Society
Scott. Micro. Soc. Proc. & Trans.	Proceedings and Transactions of the Scottish Microscopical Society
Scott. Natur.	A Magazine of Scottish Natural History (and Journal of the Perthshire Society of Natural Science)
Scott. Soc. Arts Trans.	Transactions of the Royal Scottish Society of Arts
Seeman, J. Bot.	The Journal of Botany, British and Foreign
Seifenfabr.	Seifenfabrikant, Der
Seifens. Ztg.	Seifensieder Zeitung und Revue über die Harz, Fett und Oelindustrie
Seine (Dep. de la)	See (France) Soc. Agr. Mem
Seine, Mem. Soc. Agric.	Memoires d'Agriculture par la Société Agricole de la Seine
Seine-et-Oise, Mem.	Memoires de la Société des Sciences Naturelles de Seine et Oise
Seism. J. Japan	Seismological Journal of Japan
Selenka, Archiv Zool.	Nederlandsches Archiv für Zoologie
Semi-Ann. Rep. Schimmel & Co.	Semi-Annual Report, Schimmel & Co., Miltitz
Senckenberg. Naturf. Ges. Abh.	Abhandlungen herausg. von der Senckenbergischen Naturforschenden Gesellschaft
Senckenberg. Naturf. Ges. Ber. o. J.	Bericht über die Senckenbergische naturforschende Gesellschaft in Frankfurt am Main
Shanghai, J.	Journal of the North-China Branch of the Royal Asiatic Society
Shanghai, J. Lit. Soc.	Journal of the Literary and Scientific Society of Shanghai
Shoe Lea, Reporter	Shoe and Leather Reporter
Shropsh. Soc. Trans.	Transactions of the Shropshire Archaeological and Natural History Society
Sicilia, Atti Soc. Acclim.	Atti della Società di Acclimazione e di Agricoltura in Sicilia
Sidereal Messenger	The Sidereal Messenger
Siebenb. Karpath. ~ Ver. Jahr.	Jahrbuch des Siebenburgischen Karpathen-Vereins
Siebold, J. Geburtshülfe	Journal für die Geburtshülfe, Frauenzimmer, etc., von Elias von Siebold
Siebold Kölliker, Zts.	Zeitschrift für wissenschaftliche Zoologie
Siebold, Lucina	Lucina; eine Zeitschrift zur Vervollkommenheit der Entbindungskunst
Siena, Atti Accad.	Atti dell' Accademia delle Scienze di Siena detta de' Fisiocritici
Silbermann, Rev. Entom.	Revue Entomologique

- Silliman, J. Singapore Roy. Asiat. Soc. J.
 Sitzber. kais. Akad. Wiss. Wien.
 Sitzb. konig. Akad. Munchen.
 Sitzber. konig. Akad. Wiss. Berlin.
 Sitzber. konig. preuss. Akad.
 Skand. Archiv Physiol.
 Skand. Naturf. Forh.
 Skand. Naturf. Mod. Forh.
 Skand. Natur. Mot. Forh.
 Skandia
 Skofitz
 Skofitz, Bot. Wochenbl.
 Skofitz, Bot. Zts.
 Smithsonian Contrib.
 Smithsonian Inst. Astro-phys. Obs. Ann.
 Smithsonian Inst. Bur. Ethnol. Report.
 Smithsonian Misc. Coll.
 Smithsonian Report.
 Snelling's Phot. J.
 Soc. Bot. Ital. Bull.
 Soc. Broteriana.
 Soc. Elvet. Sci. Naturf. Atti.
 Soc. Entom. Ross. Horae.
 Soc. Franc. Bot.
 Soc. Franc. Entom.
 Soc. Freniatr. Ital.
 Soc. Geogr. Finland.
 Soc. Helvet. Actes.
 Soc. Helvet. Sci. Naturf. Act.
 Soc. Ital. Antrop.
 Soc. Ital. Fis.
 Soc. Ital. Micro. Boll.
 Soc. Ital. Sci.
 Soc. Ital. Sci. Nat.
 Soc. Ligust. Sci. Naturf. Geogr.
 Soc. Malacol. France.
 The American Journal of Science and Arts.
 Journal of the Straits Branch of the Royal Asiatic Society. Singapore.
 Sitzungsberichte der kaiserlichen Akademie der Wissenschaften, Wien (Mathematisch-naturwissenschaftliche Klasse) Abteilungen I, IIa, IIb, III.
 Sitzungsberichte der königlich bayerischen Akademie der Wissenschaften zu München.
 Sitzungsberichte der königlich preussischen Akademie der Wissenschaften zu Berlin.
 Sitzungsberichte der königlich preussischen Akademie der Wissenschaften.
 Skandinavisches Archiv für Physiologie.
 Forhandlingar vid det af Skandinaviska Naturforskare och Lakare hållna Mote i Gotheborg.
 Forhandlingerne ved de Skandinaviske Naturforskere 11te Møde i Kjøbenhavn fra den 3die til den 14de Juli, 1873.
 Forhandlingar vid de Skandinaviska Naturforskarnes Tofte Mote i Stockholm från den 7 till den 14 Juli, 1880.
 Skandia. Tidskrift för Vetenskap och Konst; utgifven af Svenska Litteratur-Föreningen.
 See Oesterreich. Botan. Zeitschr.
 Oesterreichisches Botanisches Wochenblatt.
 Oesterreichische Botanische Zeitschrift.
 Smithsonian Contributions to Knowledge.
 Annals of the Astrophysical Observatory of the Smithsonian Institution.
 Annual Report of the Bureau of (American) Ethnology to the Secretary of the Smithsonian Institution.
 Smithsonian Miscellaneous Collections.
 Annual Report of the Board of Regents of the Smithsonian Institution, showing the Operations, Expenditures and Condition of the Institution.
 Snelling's Photographisches Journal.
 See Nuovo Giorn. Bot. Ital.
 See Coimbra, Soc. Broter. Biol.
 See Schweiz. Naturf. Ges. Verh.
 Horae Societatis Entomologicae Rossicae variis sermonibus in Russia usitatis editae.
 See Rev. Bot.
 See Rev. Ent.
 See Riv. Sper. di Freniatria.
 See Fennia.
 Actes de la Société Helvétique des Sciences Naturelles.
 See Schweiz. Natf. Ges. Verh.
 See Arch. Antropologia.
 See Nuovo Cimento.
 See Acireale, Soc. Ital. Micr. Boll.
 See (Roma), Soc. Ital. Mem.
 See Milano, Soc. Ital.
 See Genova, Soc. Ligust. Atti.
 See Ann. Malacol.

- Soc. Malacol. Ital. Bull.* See *Bull. Malacol. Ital.*
Soc. Meteorol. Ital. See *Moncalieri Oss. Boll.*
Soc. Mex. Hist. Natur. See *Naturaleza*
Soc. Napoli Società reale di Napoli. *Rendiconto dell' Accademia delle Scienze fisiche e matematiche*
Soc. Nat. Sicil. See *Nat. Sicil.*
Soc. Pharm. Anvers See *J. de Pharm.*
Soc. Public Analysts See *Analyst*
Soc. Speleol. See *Spelunca, Paris*
Soc. Telegr.-Engin. Elect. See *Telegr. Eng. J.*
Soc. Tosc. Sci. Nat. See *Pisa Soc. Tosc.*
Soc. Ven. Trent. Sci. Nat. See *Padova Soc. Sci.*
Soc. Zool. Skisse Ann. See *Rev. Suisse: Zool.*
Soc. Zool. Tokyo See *Annot. Zool. Jap.*
Somerset. Archaeol. Soc. Proc. Proceedings of the Somersetshire Archaeological and Natural History Society
Somerset. Sov. Proc. Somersetshire Archaeological and Natural History Society's Proceedings
Somme (Dep. de la) See under Amiens
Southern Pharm. J. Southern Pharmaceutical Journal
Span. P. Spanish Patent
Spatula Saptula (The), Boston
Spelunca, Paris Spelunca. Bulletin de la Société de Spelologie
Sperimentale Io Sperimentale. Giornale Italiano di Scienze Meiche
Spettatore Vesuvio Io Spettatore del Vesuvio e de' Campi Flegrei
Spettrosc. Ital. Mem. Memorie della Società degli Spettroscopisti Italiani
Spongia, Comm. Med. Commentarii di Medicina
Sprechsaal Sprechsaal
Sprengel, Jahr. Jahrbucher der Gewächskunde
Sprengst. Waffen Mun. Sprengstoffe, Waffen und Munition
St. Andrew's Med. Grad. Assoc. Trans. Transactions of the St. Andrew's Medical Graduates Association
St. Barthol. Hosp. Reports St. Bartholomew's Hospital Reports
St. Etienne, Bull. Soc. Ind. Mineral Bulletin de la Société de l'Industrie Minérale
St. Gallen, Ber. Naturwiss. Ges. Berichte über die Thätigkeit der St. Gallischen Naturwissenschaftlichen Gesellschaft
St. Louis, Bot. Gard. Report Missouri Botanical Garden Report
St. Louis, Trans. Acad. Sci. The Transactions of the Academy of Science of St. Louis
St. Petersb. Acad. Sci. Bull. Bulletin scientifique publie par l'Academie Imperiale des Sciences de St. Petersburg
St. Petersb. Acad. Sci. Compt. rend. Compte Rendu de l'Academie Imperiale des Sciences de St. Petersburg
St. Petersb. Acad. Sci. Mem. Memoires de l'Academie Imperiale des Sciences de St. Petersburg
St. Petersb. Acad. Sci. Nova Acta. Nova Acta Academiae Scientiarum Imperialis Petropolitanae
St. Petersb. Acad. Sci. Recueil Recueil des Actes des Seances Publiques de l'Academie Imperiale des Sciences de St. Petersburg
St. Petersb. Ann. Mines Russ. Annuaire du Journal des Mines de Russie
St. Petersb. Archiv. Sci. Biol. Archives des Sciences Biologiques publiees par l'Institut Imperial de Medecine Experimentale a St. Petersburg
St. Petersb., Congr. Bot. Bull. Bulletin du Congres International de Botanique et d'Horticulture de St. Petersburg le 6/18, le 8/20 et le 10/22 Mai 1869

- St. Petersburg. Inst. Med. See St. Petersburg. Arch. Sci. Biol. Exper.
- St. Petersburg. Med. Zts. St. Petersburg Medicinische Zeitschrift
- St. Petersburg. Med. Wochenschr. St. Petersburg Medicinische Wochenschrift
- St. Petersburg. Mem. Savants Memoires presentes a l' Academie Imperiale des Sciences de St. Petersburg par divers Savants
- St. Petersburg. Mineral. Ges. Verhandlungen der Russisch-Kaiserlichen Mineralogischen Gesellschaft zu St. Petersburg
- St. Petersburg., Russ. Geogr. Mem. (Geogr.) Memoirs de la Société Imperiale Russe de Geographie
- St. Petersburg., Russ. Geogr. Soc. Bull. Section de Geographie generale
- St. Petersburg. Schr. Mineral. Bulletins of the Imperial Russian Geographical Society
- Schriften der in St. Petersburg gestifteten Kaiserlich-Russischen Gesellschaft für die gesammte Mineralogie
- St. Petersburg. Verh. Mineral. Ges. Verhandlungen der Kaiserlich-Russischen Mineralogischen Gesellschaft zu St. Petersburg
- St. Petersburg. Verm. Abh. Vermischte Abhandlungen aus dem Gebiete der Heilkunde von einer Gesellschaft pract. Aerzte zu St. Petersburg. Additional title in 1835, Medizinisch-praktische Abhandlung von Deutschen in Russland lebenden Aerzten. Continued as the Neue Abhandlung St. Petersburg
- St. Quentin, Ann. Annales Agricoles du departement de l'Aisne, publiees par la Société des Sciences, Arts, Belles-Lettres, et Agriculture de St. Quentin. Annales Scientifiques, Agricoles, et Industrielles du departement de l'Aisne (Société Academique de Saint Quentin)
- St. Quentin, Mem. Memoires de la Société des Sciences, Arts, Belles-Lettres, et Agriculture de la ville de St. Quentin
- St. Quentin, Seances Publ. Société des Sciences, Arts, Belles-Lettres, et Agriculture de la ville de St. Quentin. Seances publiques.
- St. Quentin, Travaux Société Academique des Sciences, Arts, Belles-Lettres, et Agriculture de St. Quentin (Aisne)
- St. Thomas's Hosp. Reports St. Thomas's Hospital Reports
- Stahl Eisen (Zts) Stahl und Eisen, Zeitschrift für das deutsche Eisenhüttenwesen
- Stavanger Mus. Aarsber. Stavanger Museums Aarsberetning
- Staz. sper. agrar. ital. Stazioni sperimentali agraria italiana, La
- Steiermark. Geog. Mont. Bericht des Geognostisch-montanistischen Vereins für Steiermark
- Ver. Ber. Mittheilungen des Naturwissenschaftlichen Vereines für Steiermark
- Steiermark. Mont. Lehranst. Jahr. Die Steiermarkisch ständische montanistische Lehranstalt zu Vordernberg
- Stein, Ann. Annalen der Geburtshilfe überhaupt und der Entbindungsanstalt zu Marburg insbesondere
- Stettin, Entom. Ztg. Entomologische Zeitung; herausg. v. d. Entomologischen Vereine zu Stettin
- Steyermärk. Zts. Steyermärkische Zeitschrift
- Stirling Field Club Trans Stirling Field Club. . . . Transactions
- Stirling Soc. Trans. Stirling Natural History and Archaeological Society. Transactions
- Stockholm, Akad. Handl. Kongliga Svenska Vetenskaps Akademiens Handlingar
- Stockholm, Bihang Akad. Handl. Bihang till Kongl. Svenska Vetenskaps Akademiens Handlingar
- Stockholm Bot. Sällsk. See Bot. Centrbl.

Stockholm Entom. För.	See Ent. Tidskr.
Stockholm, Horti Bergiani Acta	Acta Horti Bergiani. Meddelanden från Kongl. Svenska Vetenskaps-Akademiens Trädgård Bergielund utgifna af Bergianska Stiftelser
Stockholm, Öfversigt	Öfversigt af Kongl. Vetenskaps Akademiens Förhandlingar
Stockholm Physiol. Lab. Mitth.	Mittheilungen vom Physiologischen Laboratorium des Carolinischen Medico-Chirurgischen Instituts in Stockholm
Stockholm, Svenska Läk. Sällsk. Handl.	Handlingar ved Svenska Läkare-Sällskapet
Stockholm, Vet. Akad. Lefnadsteckn.	Lefnadsteckningar öfver Kongl. Svenska Vetenskaps-Akademiens efter år 1854 aflidna Ledamöter
Stockholm, Ymer	Ymer. Tidskrift utgifven af Svenska Sällskapet för Antropologi och Geografi
Strasbourg Soc. Hist. Natur. Mem.	Mémoires de la Société du Museum d'Histoire Naturelle de Strasbourg
Strasbourg Soc. Sci. Bull.	Bulletin de la Société des Sciences Naturelles de Strasbourg
Strasbourg Soc. Sci. J.	Journal de la Société des Sciences, Agriculture, et Arts, du departement du Bas-Rhin
Strasbourg Soc. Sci. Mem.	Mémoires de la Société des Sciences, Agriculture, et Arts, de Strasbourg
Stray Feathers	Stray feathers. A journal of Ornithology for India and its dependencies
Stricker	See Medizin. Jahr.
Sts. Settl. P.	Straits Settlement Patent
Student	The Student and Intellectual Observer of Science, Literature, and Art
Sturgeon, Ann. Elect.	Annals of Electricity, Magnetism, and Chemistry, and Guardian of Experimental Science
Sturgeon, Ann. Phil.	Annals of Philosophical Discovery and Monthly Reporter of the Progress of Practical Science
Sucr.	La sucrerie indigene
Sucr. Belge	Sucrerie Belge, La
Sucr. ind. colon.	Sucrerie indigene et coloniale, La
Suddcut. Apoth. Ztg.	Süddeutsche Apotheker Zeitung
Suisse Soc. Zool. Ann.	See Rev. Suisse Zool.
Surveyor	Surveyor and Municipal and County Engineer, The
Sussex Natur. Hist. Soc. Proc.	See Brighton Nat. Hist. Soc. Proc.
Svea	Svea. Tidskrift för Vetenskap och Konst
Svensk farm. Tidskr.	Svensk farmaceutisk Tidskrift, Stockholm
Svensk Kem. Tidskr.	Svensk Kemisk Tidskrift
Svenska Läk. Sällsk. Förh.	Forhandlingar ved Svenska Läkare-Sällskapets Sammankomster
Svenska Mosskulturför.	Svenska Mosskulturföreningens
Svenska Sällsk. Antrop. & Geogr.	See Stockh., Ymer
Swart, Verh.	Verhandelingen en Berigten betrekkelijk het Zeewezen en de Zeewaartkunde
Swed. P.	Swedish Patent
Swiss P.	Swiss Patent
Sydney	See New South Wales
Sydney Aust. Mus. Mem.	The Australian Museum, Sydney. Memoirs
Sydney, Austral. Mus. Records	Records of the Australian Museum
Symons, Meteorol. Mag.	Symon's monthly Meteorological Magazine
Tablettes Zool.	Tablettes Zoologiques

Tagbl. Frankf. Naturf.	Tageblatt Frankfurter Naturforscher
Taprobanian	The Taprobanian, a Dravidian Journal of Oriental Studies in and around Ceylon, in Natural History, Archaeology, Philology, History
Tasmania J. Natur. Sci.	The Tasmanian Journal of Natural Science, Agriculture, Statistics, etc.
Tasmania P.	Tasmanian Patent
Tasmania, Roy. Soc. Monthly Not.	Monthly Notices of Papers and Proceedings of the Royal Society of Tasmania
Tasmania, Roy. Soc. Reports	Reports of the Royal Society of Tasmania
Taylor, Sci. Mem.	Scientific Memoirs, selected from the Transactions of Foreign Academies and Learned Societies and from Foreign Journals
Tech. Blätter	Technische Blätter. Vierteljahrschrift des Deutschen Polytechnischen Vereins in Böhmen
Tech. Chem. Jahr.	Technisch-Chemisches Jahrbuch (Biedermann)
Tech. Gemeindebl.	Technisches Gemeindeblatt
Technikum	Technikum des Ledermarkts
Technol.	Le Technologiste (F. Malepeyre)
Technol. Quart.	Technology Quarterly
Teign Field Club Proc.	Reports of the Proceedings of the Teign Naturalists' Field Club
Tekn. Tidskr.	Teknisk Tidskrift
Telegr. Eng. J.	Journal of the Society of Telegraph-Engineers and Electricians
Telegr. J.	The Telegraphic Journal and Electrical Review
Telegr. Ver. Zts.	Zeitschrift des Deutsch-österreichischen Telegraphen-Vereins
Temminck, Verh.	Verhandelingen over de natuurlijke Geschiedenis der Nederlandsche overzeesche bezittingen, door de leden der Natuurkundige Commissie in Oost-Indië en andere schrijvers
Termr. Fü.	Termesztudományi Füzetek. Kiadja a Magyar Nemzeti Múzeum. (Natural History Magazine. published by the Hungarian National Museum)
Termt. Közlön.	Termesztudományi Közlemények. Kiadja a K. M. Termesztudományi Társulat. (Natural Science Papers. Published by the Royal Hungarian Natural Science Society)
Terrestrial Magn.	Terrestrial Magnetism (and Atmospheric Electricity). An International Quarterly Journal
Texas Acad. Sci. Trans.	Transactions of the Texas Academy of Science
Text. Amer.	Textile American
Text. Col.	The Textile Colorist
Text. Färb. Ztg.	Textil und Färberei-Zeitung
Text. Mfr.	The Textile Manufacturer
Text. Rec.	The Textile Record
Text. World Rec.	Textile World Record
Text. Ztg.	Textil Zeitung
Textilfreund	Der Textilfreund
Teyler's Verh.	Geologische Verhandeling af Antwoord af de in 1828 uitgeschrevene en in 1830 herhaalde Pryspraak: Wat men van Geologie, etc.
Therap. Gaz.	The Therapeutic Gazette
Therap. Monats.	Therapeutische Monatshefte
Therap. Neuheit	Therapeutischen Neuheiten, Leipzig
Therapist	Therapist (The) London

Thomson, Ann. Phil.	Annals of Philosophy, or Magazine of Chemistry, Mineralogy, Mechanics, and the Arts
Thomson, Archiv. Entom.	Archives Entomologiques
Thomson, Rec.	Records of General Science
Thonind. Ztg.	Thonindustrie-Zeitung
Throndhjem, Skrifter	Der Kongelige Norske Videnskabers-Selskabs Skrifter i det 19 de Aarhundrede
Tidskr. Kemi. Farm. Terapi	Tidskrift for Kemi Farmaci Terapi
Tidskr. Mat.	Tidsskrift for Matematik
Tidskr. Mat. Fys.	Tidskrift for Matematik och Fysik, tillegnad den Svenska Elementar-Undervisningen
Tidskr. Phys. Chem.	Tidskrift for Physik og Chemi samt disse Videnskabers Anvendelse
Tiedemanni, Zts.	Zeitschrift für Physiologie
Tijdschr. Entom.	Tijdschrift voor Entomologie; uitgegeven door de Nederlandsche Entomologische Vereeniging
Tijdschr. Genootsch. Vis. Unita	Tijdschrift voor Genees-, Heel-, Verlos-, en Scheikundige Wetenschappen, van Wege et Genootschap: "Vis Unita Fortior," te Hoorn.
Tijdschr. Ing.	Tijdschrift van het Koninklijk Instituut van Ingenieurs
Tijdschr. wjv.	Tijdschrift ter befordering van nijverhed
Tijdstroom.	De Tijdstroom; Maandschrift gewijd van Wetenschap, etc.
Tilesius, Jahr.	Jahrbuch der Naturgeschichte zur Anzeige und Prüfung
Timehri	Timehri being the Journal of the Royal Agricultural and Commercial Society of British Guiana
Tirol, Ber. Ver. Durchf.	Bericht über die General-Versammlung des Vereins zur geogr. montan. Durchforschung des Landes Tirol, etc.
Tischl. Ztg.	Deutsche Tischlerzeitung
Tokio Univ. Mem.	Memoirs of the Science Department, University of Tokio, Japan
Tokyo Bot. Soc.	See Bot. Mag., Tokyo
Tokyo, Coll. Sci. J.	The Journal of the College of Science, Imperial University, Japan
Tokyo Geogr. Soc. J.	Journal of the Tokio Geographical Society
Tonind. Ztg.	Tonindustrie Zeitung
Töpfer Ztg.	Deutsche Töpfer und Ziegler Zeitung
Torino, Accad. Sci. Atti	Atti della R. Accademia delle Scienze di Torino
Torino, Accad. Sci. Mem.	Memoire della R. Accademia delle Scienze di Torino
Torino, Ann. Clin.	Annali Clinici
Torino, Lavori Sci. Fis. Mat.	Notizia storica dei lavori fatti dalla Classe di Scienze Fisiche e Matematiche della R. Accademia delle Scienze negli anni 1864-65
Torino Mus. Boll.	Bollettino dei Musei di Zoologia ed Anatomia comparata della R. Università di Torino
Torrey Bot. Club Bull.	Bulletin of the Torrey Botanical Club
Torrey Bot. Club Mem.	Memoirs of the Torrey Botanical Club
Tortolini, Ann.	Annali di Scienze, Matematiche, e Fisiche
Toulouse Acad. Sci. Bull.	Bulletin de l'Academie des Sciences, Inscriptions et Belles-Lettres de Toulouse
Toulouse, Acad. Sci. Mem.	Memoires de l'Academie des Sciences, Inscriptions et Belles-Lettres de Toulouse
Toulouse Fac. Sci. Ann.	Annales de la Faculte des Sciences de Toulouse, pour les Sciences Mathematiques et les Sciences Physiques
Toulouse Obs. Ann.	Annales de l'Observatoire Astronomique, Magnetique et Meteorologique de Toulouse.

Toulouse Soc. Hist. Natur. Bull.	Bulletin de la Société d'Histoire Naturelle de Toulouse
Toulouse Soc. Sci. Bull.	Bulletin de la Société des Sciences Physiques et Naturelles de Toulouse
Trans. Acad. Sci. St. Louis	Transactions of the Academy of Sciences of St. Louis
Trans. Amer. Ceram. Soc.	Transactions of the American Ceramic Society
Trans. Amer. Electrochem. Soc.	Transactions of the American Electrochemical Society
Trans. Amer. Inst. Chem. Eng.	Transactions of the American Institute of Chemical Engineers
Trans. Amer. Inst. Homoeop.	Transactions of the American Institute of Homoeopathy, Philadelphia
Trans. Amer. Inst. Min. Eng.	Transactions of the American Institute of Mining Engineers
Trans. Amer. Med. Assoc. Sec. Pharm. Therap.	Transactions of the Section on Pharmacology and Therapeutics of the American Medical Association
Trans. Amer. Micro. Soc.	Transactions of the American Microscopical Society
Trans. Amer. Soc. Civ. Eng.	Transactions of the American Society of Civil Engineers
Trans. Cambr. Phil. Soc.	Transactions of the Cambridge Philosophical Society
Trans. Can. Inst.	Transactions of the Canadian Institute
Trans. Engl. Ceram. Soc.	Transactions of the English Ceramic Society
Trans. Faraday Soc.	Transactions of the Faraday Society
Trans. Geol. Soc. S. Africa	Transactions of the Geological Society of South Africa
Trans. Illum. Eng. Soc.	Transactions of the Illuminating Engineering Society
Trans. Inst. Brew.	Transactions of the Institute of Brewing
Trans. Jenner Inst. Prev. Med.	Transactions of the Jenner Institute of Preventive Medicine
Trans. Kansas Acad. Sci.	Transactions of the Kansas Academy of Science
Trans. Med.	Transactions Medicales; Journal de Médecine pratique
Trans. Min. Geol. Inst. India	Transactions of the Mining and Geological Institute of India
Trans. Natl. Eclec. Med. Assoc.	Transactions National Eclectic Medical Association, Indianapolis
Trans. Nova Scotia Inst. Sci.	Transactions of the Nova Scotia Institute of Science
Transv. P.	Transvaal Patent
Trans. Path. Soc.	Transactions of the Pathological Society
Trans. Roy. Irish Acad.	Transactions of the Royal Irish Academy
Trans. Roy. Soc. Can.	Transactions of the Royal Society of Canada
Trans. Roy. Soc. Edinb.	Transactions of the Royal Society of Edinburgh
Trans. Roy. Soc. London	Transactions of the Royal Society of London
Trans. Soc. Engin.	Society of Engineers, Transactions
Trav. Com. Hyg. Publ.	Recueil des Travaux du Comité consultatif d'Hygiène Publique de France et des Actes Officiels de l'Administration Sanitaire
Trenton Natur. Hist. Soc. J.	Journal of the Trenton, New Jersey, Natural History Society
Treviso, Mem. Ateneo	Memorie Scientifiche e Letterarie dell' Ateneo di Treviso
Trier, Jahr.	Jahresbericht der Gesellschaft für nützliche Forschungen zu Trier
Triest Zool. Sta. Arb.	See Wien. Zool. Inst. Arb.
Trieste, Boll.	Bollettino della Società Adriatica di Scienze Naturali in Trieste
Trieste Mus. Civ. Atti	Atti del Museo Civico di Storia Naturale di Trieste
Trieste, Program. Civ. Scuola	Programma della Civica Scuola Reale autonoma in Trieste

Trinidad Field Natur. Club J.	Journal of the Trinidad Field Naturalists' Club
Trinidad P. *	Trinidad Patent
Trinidad, Proc. Sci. Assoc.	Proceedings of the Scientific Association of Trinidad
Trinidad, Sci. Assoc. Proc.	Proceedings of the Scientific Association of Trinidad
Trommsdorff, J. Pharm.	Journal der Pharmacie für Aerzte und Apotheker, und Chemiker
Tromso. Mus., Aarsh.	Tromso Museums Aarshefter
Tropenpflanzer	Tropenpflanzer (Der), Berlin
Tsch. Mineral. Mitth.	Tschermak's Mineralogische Mitteilungen
Tuberculosis	Tuberculosis. The Journal of the National Association for the Prevention of Consumption and other forms of Tuberculosis
Tübinger Blätter *	Tübinger Blätter für Naturwissenschaften und Arzneikunde
Tübingen Bot. Inst. Unt.	Untersuchungen aus dem Botanischen Institut zu Tübingen
Tunis P.	Tunis Patent
Turin, Mem. Acad.	Memoires de l'Academie Royale des Sciences de Turin
Tyneside Natur. Field Club Trans.	Transactions of the Tyneside Naturalist's Field Club
U. K. Mar. Biol. Assoc. J.	Journal of the Marine Biological Association of the United Kingdom
U. S. Bur. Anim. Ind. Bull.	U. S. Department of Agriculture. Bureau of Animal Industry
U. S. Bur. Anim. Ind. Report	Annual Report of the Bureau of Animal Industry
U. S. Chief Signal Off. Ann. Report	Annual Report of the Chief Signal Officer (of the Army) to the Secretary of War
U. S. Coast Geod. Surv. Bull.	United States Coast and Geodetic Survey. Bulletin
U. S. Comm. Agric. Report	Report of the Commissioner of Agriculture
U. S. Dept. Agric. Bull.	Bulletins of the Department of Agriculture, U. S.
U. S. Dept. Agric. Report	Reports of the Department of Agriculture, U. S.
U. S. Dept. Agric. Yearb.	Yearbook of the United States Department of Agriculture
U. S. Disp.	United States Dispensary
U. S. Div. Biol. Surv. Bull.	U. S. Department of Agriculture. Division of Biological Survey. Bulletin
U. S. Div. Chem. Bull.	U. S. Department of Agriculture. Division of Chemistry. Bulletin
U. S. Div. Entom. Bull.	U. S. Department of Agriculture. Division of Entomology
U. S. Div. Entom. Insect Life	U. S. Department of Agriculture. Division of Entomology. (Periodical Bulletin.) Insect Life
U. S. Div. Entom. Tech. Ser.	U. S. Department of Agriculture. Division of Entomology. Technical Series
U. S. Div. Ornith. Mamm. Bull.	U. S. Department of Agriculture. Division of Economic Ornithology and Mammalogy. Bulletin
U. S. Div. Soils Bull.	U. S. Department of Agriculture. Division of (Agricultural) Soils. Bulletin
U. S. Entom. Comm. Bull.	Department of the Interior. . . Bulletin of the United States Entomological Commission
U. S. Entom. Comm. Report	(U. S.) Department of the Interior (Agriculture) . . . Report of the United States Entomological Commission
U. S. Fish Comm. Bull.	Bulletin of the United States Fish Commission
U. S. Fish Comm. Report	United States Commission of Fish and Fisheries. Report of the Commissioner

U. S. Geol. Surv.	United States Geological Survey
U. S. Monthly Weath. Rev.	(United States) Monthly Weather Review
U. S. Mus. Bull.	Department of the Interior... Bulletin of the United States National Museum
U. S. Mus. Proc.	Department of the Interior... Proceedings of the United States National Museum
U. S. Mus. Report	See Smithsonian Rep.
U. S. Mus. Spec. Bull.	Smithsonian Institution. United States National Museum. Special Bulletin
U. S. Naval Inst. Proc.	United States Naval Institute Proceedings
U. S. Naval Med. Bull.	United States Naval Medical Bulletin
U. S. Naval Obs. Publ.	Publications of the United States Naval Observatory
U. S. N. Amer. Fauna	U. S. Department of Agriculture. Division of Ornithology and Mammalogy. North American Fauna
U. S. P.	United States Patent
U. S. Ph.	United States Pharmacopoeia
U. S. Secty. Agric. Report	Report of the secretary of agriculture
U. S. Signal Serv. Notes	United States of America: War Department. Signal Service Notes
U. S. Signal Serv. Pap.	United States of America, War Department. Professional Papers of the Signal Service
U. S. Surv. Terr. Reports	... Annual Report of the United States, Geological (and Geographical) Survey of the Territories
U. S. Weath. Bur. Bull.	U. S. Department of Agriculture. Weather Bureau. Bulletin
U. S. Weath. Bur. Report	U. S. Department of Agriculture. Weather Bureau. Report of the Chief of the Weather Bureau
U. Serv. Inst. J.	Journal of the royal United Service Institution, Whitehall Yard
Udine, Relazioni	Relazioni intorno agli Atti dell' Accademia di Udine
Uhland's Tech. Rund.	Uhland's Technische Rundschau
Umschau	Umschau, Die
Ung. Naturwiss. Ver. Jahr.	Abhandlungen aus dem dritten Bande der Jahrbücher des Ungarischen naturwissenschaftlichen Vereins zu Pest, in Deutscher Uebersetzung Red. von J. Szabo
Univ. Ill. Bull.	University of Illinois Bulletin
Unters. Naturlehre	Untersuchungen zur Naturlehre des Menschen und der Thiere
Uppsala, Arsskrift	Universitets Arsskrift utgifven af Kongl. Vetenskaps-Societeten i Uppsala
Uppsala Bot. For.	See Bot. Notiser
Uppsala, Diss. Acad.	Dissertationes Academicæ Upsaliæ habitæ
Uppsala, Frey Tidskr.	Frey Tidskrift for Vetenskap och Konst
Uppsala Läkareför. Förh.	Uppsala Läkareforenings Förhandlingar
Uppsala Naturvet. Student-sällsk.	See Bot. Centrbl.
Uppsala, Soc. Sci. Nova Acta	Nova Acta Regiæ Societatis Scientiarum Upsaliensis
Urug. P.	Uruguay Patent
Utrecht, Aanteek. Prov. Genoots.	Aanteekeningen van het Verhandelde in de Sectie-Vergaderingen van het Provinciaal Utrechtsch Genootschap van Kunsten en Wetenschappen
Utrecht, Ann. Acad.	Annales Academiæ Rheno-Trajectinæ
Utrecht, Kliniek	Kliniek: Tijdschrift voor Wetenschappelijke Geneeskunde
Utrecht, Nieuwe Verh. Prov. Genootsch.	Nieuwe Verhandelingen van het Provinciaal Utrechtsch Genootschap van Kunsten en Wetenschappen

Utrecht, Onderzoek.	Onderzoekingen gedaan in het Physiologisch Laboratorium der Utrechtsche Hoogeschool
Utrecht, Scheik. Onderzoek.	Scheikundige Onderzoekingen, gedaan in het Laboratorium der Utrechtsche Hoogeschool
Utrecht, Verh. Prov. Genootsch.	Verhandelingen van het Provinciaal Utrechtsch Genootschap van Kunsten en Wetenschappen
Valais Soc. Murith.	See Bull. Murith.
Valencia, Act. Med.	Actas del Instituto Medico Valenciano
Valenciennes, Mem. Soc. Agric.	Memoires de la Société d'Agriculture, des Sciences, et des Arts, de l'Arrondissement de Valenciennes
Valentin, Rep.	Repertorium für Anatomie und Physiologie
Van Diemen's Land, Roy. Soc. Papers.	Papers and Proceedings of the Royal Society of Van Diemen's Land
Van Diemen's Land, Roy. Soc. Reports	Reports of the Royal Society of Van Diemen's Land (For Horticulture, Botany, and the Advance of Science)
Van Nostrand's Mag.	Van Nostrand's Engineering Magazine
Vargasia	Vargasia: Boletín de la Sociedad de Ciencias físicas y naturales de Caracas
Varsovie Soc. Natur. Trav.	Comptes Rendus et Memoires de la Société des Naturalistes (a l'Université Imperiale) de Varsovie
Varsovie Soc. Natur. Trav. (Mem.)	Travaux de la Société des Naturalistes de l'Université Imperiale de Varsovie
Vauchuse Acad. Mem.	Memoires de l'Académie de Vauchuse
Venez. P.	Venezuela Patent
Venezia, Ateneo	L'Ateneo Veneto: Rivista mensile di Science, Lettere ed Arti
Venezia, Ateneo Escreit.	Esercitazioni Scientifiche e Letterarie dell' Ateneo di Venezia
Venezia, Atti	Atti delle Adunanze dell' I. R. Istituto Veneto di Scienze, Lettere, ed Arti
Venezia, Atti Ateneo	Atti dell' Ateneo Veneto
Venezia, Iat. Atti	Atti del Reale Istituto Veneto di Scienze, Lettere ed Arti
Venezia, Ist Mem.	Memorie del Reale Istituto Veneto di Scienze, Lettere ed Arti
Venezia, Mem. Ist Beneto	Memorie dell' I. R. Istituto Veneto di Scienze, Lettere, ed Arti
Ver. Anf. Chem.	See Repert. Anal. Chem.
Verh. Genootsch. Occ. Qui Non.	Verhandelingen van het Genootschap: "Occidir qui qui non servat."
Verh. Ges. deut. Naturf. Aerzte	Verhandlung der Gesellschaft deutscher Naturforscher und Aerzte
Verh. poly. Ges.	Verhandlungen der poltechnischen Gesellschaft
Verh. Ver. Gewerbeleis.	Verhandlungen des Vereins zur Beförderung des Gewerbeleisses in Preussen
Veröffent. kais. Gesundh.	Veröffentlichungen des kaiserlichen Gesundheitsamts
Verona, Soc. Ital. Mem.	Memorie di Matematica e Fisica della Società Italiana della Scienze
Vet. J. London	Veterinary Journal, London
Vet. Med. Assoc. Trans.	Transactions of the Veterinary Medical Association
Veterinarian	The Veterinarian
Victoria Dept. Mines Spec. Reports	Victoria. Department of Mines. Special Reports
Victoria Field Natur. Club	See Victorian Natlist.
Victoria Inst. J.	Journal of the Transactions of the Victoria Institute or Philosophical Society of Great Britain
Victoria Natur.	The Victorian Naturalist. The Journal and Magazine of the Field Naturalists' Club of Victoria

Victoria P.	Victoria Patent
Victoria Pharm. Soc. J.	Quarterly Journal and Transactions of the Pharmaceutical Society of Victoria
Victoria Proc. Roy. Soc.	Proceedings of the Royal Society of Victoria
Victoria Trans. Phil. Inst.	Transactions of the Philosophical Institute (afterwards Royal Society) of Victoria
Victoria Trans. Roy. Soc.	Transactions of the Royal Society of Victoria
Victoria Zool. Soc. Proc.	Proceedings of the Zoological and Acclimatisation Society of Victoria
Vierteljahrshr. ärzt. poly.	Vierteljahrsschrift der ärztlichen Polytechnik
Vierteljahrshr. gericht. Med.	Vierteljahrsschrift für gerichtliche Medizin und öffentliches Sanitätswesen
Vierteljahrshr. gesundheitspf.	Vierteljahrsschrift für Gesundheitspflege
Vierteljahrshr. Zahnheilk.	Vierteljahrsschrift für Zahnheilkunde
Virchow's Archiv path.	Virchow's Archiv für pathologie, Anatomie, und Histologie
Viviani, Ann. Bot.	Annali di Botanica
Voget, Notizen	Notizen aus dem Gebiete der practischen Pharmacie
Voigt, Mag.	Magazin für den neuesten Zustand der Naturkunden, mit Rücksicht auf die dazu gehörigen Hilfswissenschaften
Vosges Soc. Emul. Ann.	Annales de la Société d'Émulation du Département des Vosges
W. Austral. P.	West Australian Patent
Wag. Free Inst. Sci. Trans.	Transactions of the Wagner Free Institute of Science of Philadelphia
Wag. Jahr.	(Wagner's) Jahresbericht über Chemische Technologie
Walker, Elect. Mag.	The Electrical Magazine
Warwick. Field Club Proc.	Proceedings of the Warwickshire Naturalists' and Archaeologists' Field Club
Warwick Natur Hist. Soc. Rep.	Annual Reports of the Warwickshire Natural History and Archaeological Society
Washburn Obs. Publ.	Publications of the Washburn Observatory of the University of Wisconsin
Washington	Int. Med. Congr. Trans., 1887
Washington	See also under U. S.
Washington Biol. Soc. Proc.	Proceedings of the Biological Society of Washington
Washington, Mem. Natl. Acad.	Memoirs of the National Academy of Sciences
Washington, Natl. Inst. Bull.	Bulletin of the Proceedings of the National Institution for the Promotion of Science
Washington Phil. Soc. Bull.	Bulletin of the Philosophical Society of Washington
Wasser Abwasser	Wasser und Abwasser
Water Supply Papers	Water Supply Papers
Watford Nat. Hist. Soc. Trans.	Transactions of the Watford Natural History Society and Hertfordshire Field Club
Weale, Quart. Papers	Quarterly Papers on Engineering
Weber, Archiv	Archiv für die systematische Naturgeschichte
Weimer, Zts. Geburtsk.	Gemeinsame Deutsche Zeitschrift für Geburtskunde
Weinlaube	Die Weinlaube
Wernigerode Naturwiss. Ver. Schr.	Schriften des Naturwissenschaftlichen Vereins des Harzes in Wernigerode
West. Brewer	Western Brewer, The
West. Chem. Met.	Western Chemist and Metallurgist
West. Drug.	Western Druggist

Westphäl. Prov. Blätt.	Westphälische Provincial-Blätter. Verhandlungen der Gesellschaft zur Beförderung der vaterländischen Cultur in Minden
Westphäl. Ver. Jahr.	Jahres-Bericht des Westfälischen Provinzial-Vereins für Wissenschaft und Kunst
Wetter	Das Wetter. Meteorologische Montasschrift für Gebildete aller Stände
Wetterau. Ges. Ann.	Annalen der Wetterauischen Gesellschaft für die gesammte Naturkunde
Wetterau. Ges. Festgabe.	Naturhistorische Abhandlungen aus dem Gebiete der Wetterau
Wetterau. Ges. Jahr.	Jahresbericht der Wetterauischen Gesellschaft für die gesammte Naturkunde
Wetterau. Ges. Naturk. Ber.	Bericht der Wetterauischen Gesellschaft für die gesammte Naturkunde zu Hanau
Wiäd. Mat.	Wiadomości Matematyczne
Wieck's Gewerbeztg.	Deutsche Gewerbezeitung (F. Wieck)
Wied. Ann. Phys.	Annalen der Physik und Chemie (Wiedemann's)
Wied. Archiv	Archiv für Zoologie und Zootomie
Wied. Zool. Mag.	Zoologisches Magazin
Wiegmann, Archiv	Archiv für Naturgeschichte
Wien Abb.	Naturwissenschaftliche Abhandlungen
Wien Akad. Ber.	Sitzungsberichte der kaiserlichen Akademie der Wissenschaften; Mathematisch-Naturwissenschaftliche Klasse, II Abthlg. Wien
Wien Akad. Denkschr.	Denkschriften der kaiserlichen Akademie der Wissenschaften. Mathematisch - Naturwissenschaftliche Classe
Wien Akad. Sitzber.	Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe der kaiserlichen Akademie der Wissenschaften
Wien Almanach	Almanach der kaiserlichen Akademie der Wissenschaften
Wien Alpen-Verein, Jahr.	Jahrbuch des Oesterreichischen Alpen-Vereins
Wien Anthropol. Ges. Mitth.	Mittheilungen der Anthropologischen Gesellschaft
Wien Anz.	Anzeiger der kaiserlichen Akademie der Wissenschaften; Math.-Naturwissensch. Classe
Wien Denkschr.	Denkschriften der kaiserlichen Akademie der Wissenschaften; Mathematisch - naturwissenschaftliche Classe
Wien Embryol. Inst. Mitth.	Mittheilungen aus dem Embryologischen Institute der k. k. Universität in Wien
Wien Geogr. Ges. Abh.	Abhandlungen der k. k. Geographischen Gesellschaft in Wien
Wien Geogr. Ges. Festschr.	Festschrift der k. k. Geographischen Gesellschaft 1884-1898
Wien Geogr. Ges. Mitth.	Mittheilungen der k. k. Geographischen Gesellschaft in Wien
Wien Med. Chir. Acad. Abh.	Abhandlungen der k. k. medicinisch-Chirurgischen Josephs-Academie zu Wien
Wien Med. Chir. Acad. Beob.	Beobachtungen der k. k. medicinisch-chirurgischen Josephs-Academie zu Wien
Wien Naturhist. Hofmus. Ann.	Annalen des k. k. Naturhistorischen Hofmuseums
Wien Ornith. Vrr. Mitth.	Mittheilungen des Ornithologischen Vereins in Wien
Wien Phot. Corresp.	Photographische Correspondenz. Organ der Photograph. Gesellsch. in Wien
Wien Schr.	Schriften des Vereines zur Verbreitung naturwissenschaftlicher Kenntnisse

Wien Sitzber.	Sitzungsberichte der Mathematisch-naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften
Wien, Sonnblick-Ver. Jahr.	Jahres-Bericht des Sonnblick-Vereines. Wien
Wien. technol. Blätter	Wiener technologische Blätter
Wien Ver. Naturwiss. Kennt. Schr.	Schriften des Vereins zur Verbreitung naturwissenschaftlicher Kenntnisse in Wien
Wien, Ver. Ges. Aerzte.	Verhandlungen der k. k. Gesellschaft der Aerzte zu Wien
Wien Verh. Gewerb-Vereins.	Verhandlungen des Niederösterreichischen Gewerbevereins
Wien Wochenbl. Aerzte	Wochenblatt der k. k. Gesellschaft der Aerzte in Wien
Wien Zts. Ges. Aerzte	Zeitschrift der k. k. Gesellschaft der Aerzte zu Wien
Wien, Zool. Bot. Ges. Festschr.	Festschrift zur Feier des fünfundsapzigjährigen Bestehens der k. k. Zoologisch-Botanischen Gesellschaft in Wien
Wien, Zool. Bot. Verh.	Verhandlungen der k. k. Zoologisch-Botanischen Gesellschaft in Wien
Wien, Zool. Inst. Arb.	Arbeiten aus dem Zoologischen Institute der Universität Wien und der Zoologischen Station in Triest
Wiener Entom. Monatschr.	Wiener Entomologische Monatschrift
Wiener Entom. Ver. Jahr.	Jahresbericht des Wiener Entomologischen Vereins
Wiener Entom. Ztg.	Wiener Entomologische Zeitung
Wiener klin. Wochenschr.	Wiener klinische Wochenschrift
Wiener landw. Ztg.	Wiener landwirtschaftliche Zeitung
Wiener Med. Wochenschr.	Wiener medicinische Wochenschrift
Wiener Mitth. Phot.	Wiener Mittheilungen (Photographischen Inhalts)
Wiener Mus. Ann.	Annalen des Wiener Museums der Naturgeschichte
Wiener Poly. J.	Allgemeines Wiener polytechnisches Journal
Wiener Ztg.	Wiener Zeitung
Wiener Zts. Physik.	Zeitschrift für Physik, Chemie, und Mineralogie
Wild, Rep. Meteorol.	Repertorium für Meteorologie, herausg. von der kaiserlichen Akad. der Wissenschaften
Wilna, Collect. Med. Chir.	Collectanea medico-chirurgica Caesareae Academiae Medico-Chirurgicae cura edita
Wilts, Archaeol. Natur. Hist. Mag.	Magazine of the Archaeological and Natural History Society of Wiltshire
Wimereux Lab. (Stat.) Zool.	See Lille Inst. Zool. Trav.
Winchester, J. Sci. Soc.	Journal of Proceedings and Annual Reports of the Winchester and Hampshire Scientific and Literary Society
Wisconsin Acad. Trans.	Transactions of the Wisconsin Academy of Sciences, Arts, & Letters
Wisconsin Natur. Hist. Soc. Bull.	Bulletin of the Wisconsin Natural History Society
Wisconsin Natur. Hist. Soc. Pap.	Occasional Papers of the Natural History Society of Wisconsin
Wisconsin Natur. Hist. Soc. Proc.	Proceedings of the Natural History Society of Wisconsin
Wisconsin Univ. Bull. Sci.	Bulletin of the University of Wisconsin. Science Series
Wiss. Abh. Phys.-Tech. Reichsanstalt	Wissenschaftliche Abhandlungen der Physikalisch-Technischen Reichsanstalt
Wiss. Meeresuntersuch.	Wissenschaftliche Meeresuntersuchungen herausgegeben von der Kommission zur wissenschaftlichen Untersuchung der deutschen Meere in Kiel und der biologischen Anstalt auf Helgoland

Wochenbl. Archit. Ver.	Wochenblatt, herausgegeben von mitgliedern des Architekten-Vereins zu Berlin
Wochenbl. Papierfabr.	Wochenblatt der Papierfabriken
Wochensch. Brau.	Wochenschrift für Brauerei
Wochensch. Centr.-Ver. Rubezucker-ind.	Wochenschrift des Central-Vereins für Rubenzucker-industrie in der Oesterr.-Ung.-Monarchie
Wochensch. österr. Ing. Ver.	Wochenschrift des österreichischen Ingenieur und Architekten Vereins
Wochensch. Ver. deut. Ing.	Wochenschrift des Vereins deutscher Ingenieure
Wollen-Gewerbe	Das Deutsche Wollen-Gewerbe
Wollen Ztg.	Wollen Zeitung
Wombat	The Wombat. The Journal of the Geelong Field Naturalists' Club, and the Gordon College Amateur Photographic Association
Woods Holl Mar. Biol. Lab. Bull.	Biological Bulletin Edited by the Director and Members of the Staff, of the Marine Biological Laboratory, Woods Holl, Mass.
Woods Holl Mar. Biol. Lab. Lect.	Biological Lectures delivered at (from) the Marine Biological Laboratory (of) Woods Holl (Mass.)
Woolhope Field Club Trans.	Transactions of the Woolhope Naturalists' Field Club
Woolwich, Proc.	Minutes of Proceedings of the Royal Artillery Institution
World's Paper Trade Rev.	World's Paper Trade Review
Wunderlich, Archiv. Heilk.	See Roser und Wunderlich
Württemberg. Aerzt. Ver. Mitth.	Mittheilungen des Württembergischen Aerztlichen Vereins
Württemberg, Jahresh.	Jahreshefte des Vereins für vaterländische Naturkunde in Württemberg
Würzburg, Arb. Bot. Inst.	Arbeiten des Botanischen Instituts in Würzburg
Würzburg, Arb. Phys. Lab.	Arbeiten aus dem Physiologischen Laboratorium der Würzburger Hochschule
Würzburg. Med. Zts.	Würzburger medicinische Zeitschrift
Würzburg. Naturwiss. Zts.	Würzburger Naturwissenschaftliche Zeitschrift; Herausgegeben von der Physikalisch-Medicinischen Gesellschaft
Würzburg Phys. Med. Festschr.	Festschrift zur Feier ihres fünfzigjährigen Bestehens herausgegeben von der Physikalisch-Medicinischen Gesellschaft zu Würzburg
Würzburg, Phys. Med. Sitzber.	Sitzungsberichte der Physikalisch-Medicinischen Gesellschaft zu Würzburg
Würzburg, Phys. Med. Verh.	Verhandlungen der Physikalisch-Medicinischen Gesellschaft
Würzburg, Zool Inst. Arb.	Arbeiten aus dem Zoologisch-Zoatomischen Institut in Würzburg
Year Book Pharm.	See Brit. Pharm. Confer. Proc.
Year-book of Pharm.	Year-book of Pharmacy
Yn Lioar Manninagh	Yn Lioar Manninagh. The Journal of the Isle of Man Natural History and Antiquarian Society
Yokohama, Mitth. Deut. Ges.	Mittheilungen der Deutschen Gesellschaft für Natur und Völkerkunde Ostasiens
Yonne	See Auxere
Yonne, Bull.	Bulletin de la Société des Sciences Historiques et Naturelles de l'Yonne
Yorksh. Natur. Union Trans.	The Transactions of the Yorkshire Naturalists' Union
Yorksh. Phil. Soc. Report	Annual Report of the Council of the Yorkshire Philosophical Society

Yorksh. Proc. Phil. Soc.	Proceedings of the Yorkshire Philosophical Society
Zach, Corresp.	Correspondence Astronomique, Geographique, Hydrographique, et Statistique
Zach, Monat. Corresp.	Monatliche Correspondenz zur Beförderung der Erd- und Himmels-Kunde
Zahntech.	Die Zahntechnische Reform
Zantedeschi, Ann. Fis.	Annali di Fisica
Zeeuwsch Genootsch.	Nieuwe Verhandelingen van het Zeeuwsch Genootschap
Nieuwe Verh.	der Wetenschappen
Zeeuwsch Genootsch. Wet.	Archief Vroegere en Latere Mededeelingen voor-
Archief	namelijk in Betrekking tot Zeeland, uitgegeven door het Zeeuwsch Genootschap der Wetenschappen
Zentr. Biochem. Biophys.	Zentralblatt für Biochemie und Biophysik
Zentr. exp. Med.	Zentralblatt der experimentellen Medizin (former name Zentralblatt für die gesamte Physiologie und Pathologie des Stoffwechsels)
Zentr. inn. Med.	Zentralblatt für innere Medizin
Zentr. oesterr - ungar	Zentralblatt für die oesterr-ungar Papierindustrie
Papierind.	
Zentr. Physiol.	Zentralblatt für Physiologie
Zentr. Physiol. Path. Stoffwech.	Zentralblatt für die gesammte Physiologie und Pathologie des Stoffwechsels, Berlin und Wien
Zeuner, Civilingenieur	Der Civilingenieur, Zeitschrift für das Ingenieurwesen
Ziva	Ziva: Casopis prirodnicky
Zool. Anz.	Zoologischer Anzeiger
Zool. Beitr.	Zoologische Beiträge
Zool. Bull.	Zoological Bulletin
Zool. Congr.	See Congr. Int. Zool. C. R. Int. Congr. Zool. Proc.
Zool. Jahr.	Zoologische Jahrbücher. Zeitschrift für Systematik, Geographie und Biologie der Thiere
Zool. J.	The Zoological Journal
Zool. Soc. Proc.	Proceedings of the Scientific Meetings (General Meetings for Scientific Business) of the Zoological Society of London
Zool. Soc. Trans.	Transactions of the Zoological Society of London
Zool. Vortr.	Zoologische Vorträge
Zoologica	Zoologica. Original-Abhandlungen aus dem Gesamtgebiete der Zoologie
Zoologist	The Zoologist; a monthly Journal of Natural History
Ztg. Blechind.	Illustrierte Zeitung für Blechindustrie
Zts. Akklimat.	Zeitschrift für Akklimatisation: Organ des Akklimatisations-Vereins in Berlin
Zts. allg. Erdkunde	Zeitschrift für allgemeine Erdkunde
Zts. allg. oesterr. Apoth.-Ver.	Zeitschrift des allgemeinen österreichischen Apothekervereins
Zts. allg. Physiol.	Zeitschrift für allgemeine Physiologie
Zts. anal. Chem.	Zeitschrift für analytische Chemie
Zts. Anat.	Zeitschrift für Anatomie und Entwicklungsgeschichte
Zts. ang. Chem.	Zeitschrift für angewandte Chemie, und Zentralblatt für technische Chemie
Zts. ang. Mikr.	Zeitschrift für angewandte Mikroskopie mit besonderer Rücksicht auf die mikroskopischen Untersuchungen von Nahrungs- und Genussmitteln, technischen Produkten, Krankheitsstoffen, etc.
Zts. anorg. Chem.	Zeitschrift für anorganische Chemie
Zts. Bauwesen	Zeitschrift für Bauwesen
Zts. Berg-Hütten Salinenw.	Zeitschrift für das Berg-Hütten und Salinenwesen im Preussischen Staate
Zts. Biol.	Zeitschrift für Biologie

Zts. Bot.	Zeitschrift für Botanik
Zts. Chem.	Zeitschrift für Chemie
Zts. chem. Apparat.	Zeitschrift für chemische Apparatenkunde (Discontinued)
Zts. Chem. Ind.	Zeitschrift für die Chemische Industrie mit besonderer Berücksichtigung der chemisch-technischen Untersuchungsverfahren 1887; later Zts. ang. Chem.
Zts. chem. Ind. Kolloide	Zeitschrift für Chemie und Industrie der Kolloide
Zts. Chemotherap.	Zeitschrift für Chemotherapie und verwandte Gebiete. (formerly Folia Serologia)
Zts. deut. geol. Ges. Abh.	Zeitschrift der deutschen geologischen Gesellschaft Abhandlungen
Zts. deut. Landw.	Zeitschrift für deutsche Landwirthe
Zts. Dreschler	Zeitschrift für Dreschler, Elfenbeingraveur und Holzbildhauer
Zts. Düngerw.	Zeitschrift für Düngerwesen
Zts. Electrochem.	Zeitschrift für Electrochemie
Zts. Entom. (Breslau)	Zeitschrift für Entomologie im Auftrage des Vereins für schlesische Insektenkunde zu Breslau
Zts. Ethnol.	Zeitschrift für Ethnologie
Zts. exper. Path., Therap.	Zeitschrift für experimentelle Pathologie und Therapie, Berlin
Zts. Farben Ind.	Zeitschrift für Farben-Industrie
Zts. Feuerwehr.	Illustrierte Zeitschrift für die deutsche Feuerwehr
Zts. Fischerei	Zeitschrift für Fischerei
Zts. Fleisch. Milchhyg.	Zeitschrift für Fleisch- und Milchhygiene
Zts. Geburtsh.	Zeitschrift für Geburtshülfe und Frauenkrankheiten
Zts. Geburtsh. Gynäkol.	Zeitschrift für Geburtshülfe und Gynäkologie
Zts. ges. Brauw.	Illustrierte Zeitschrift das gesamte Brauwesen
Zts. ges. Getreidew.	Zeitschrift für das gesamte Getreidewesen
Zts. ges. Naturwiss.	Zeitschrift für die Gesamten Naturwissenschaften
Zts. Ges. Ornith.	Zeitschrift für die gesamte Ornithologie
Zts. ges. Textilind.	Zeitschrift für die gesamte Textilindustrie
*Zts. ges. Wasserwirts.	Zeitschrift für die gesamte Wasserwirtschaft
Zts. Heilk.	Zeitschrift für Heilkunde, als Fortsetzung der Prager Vierteljahrsschrift für praktische Heilkunde
Zts. Hyg.	Zeitschrift für Hygiene und Infektionskrankheiten
Zts. Immunit. Abt. I. 13.	Zeitschrift für Immunitätsforschung und experimentelle Therapie. Abteilung I. 13. Abteilung II. or Ref. 1 vol.
Abt. Rgf.	
Zts. Induk. Abst. Vererbungslehre	Zeitschrift für Induktive Abstammungs- und Vererbungslehre
Zts. Instrumentenk.	Zeitschrift für Instrumentenkunde
Zts. Klin. Med.	Zeitschrift für Klinische Medizin
Zts. Krebsforsch.	Zeitschrift für Krebsforschung
Zts. Kryst. Mineral	Zeitschrift für Krystallographie und Mineralogie
Zts. landw. Versuchsw.	Zeitschrift für das landwirtschaftliche Versuchswesen in Oesterreich
Zts. Malakozool.	Zeitschrift für Malakozoologie
Zts. Math. Phys	Zeitschrift für Mathematik und Physik
Zts. math. Unterr.	Zeitschrift für mathematischen und naturwissenschaftlichen Unterricht
Zts. Mikro. Tek.	Zeitschrift für Mikroskopischen Technik.
Zts. Morphol. Anthropol.	Zeitschrift für Morphologie und Anthropologie
Zts. Nahr. Genuss. (Z. genuss)	Zeitschrift für Untersuchung der Nahrungs- und Genussmittel, sowie der Gebrauchsgegenstände
Zts. Naturwiss.	Zeitschrift für Naturwissenschaften...im Auftrage (Organ) des Naturwissenschaftlichen Vereins für Sachsen und Thüringen

Zts. öffentl. Chem.	Zeitschrift für öffentliche Chemie
Zts. Ohrenheilk.	Zeitschrift für Ohrenheilkunde in deutscher und englischer Sprache
Zts. österr. Ing. Ver.	Zeitschrift des österreichischen Ingenieur und Architekten Vereins
Zts. paraf. Ind.	Zeitschrift für Parafin Industrie
Zts. Parasit.	Zeitschrift für Parasitenkunde
Zts. Pflanzenkrankheiten	Zeitschrift für Pflanzenkrankheiten
Zts. physik. Chem.	Zeitschrift für physikalische Chemie, Stöchiometrie und Verwandschaftslehre
Zts. Physik. Chem. Unterr.	Zeitschrift für dem physikalischen und chemischen Unterricht
Zts. Physiol. Chem.	Zeitschrift für physiologische Chemie (Hoppe-Seylers)
Zts. prakt. Geol.	Zeitschrift für praktische Geologie
Zts. Psychol.	Zeitschrift für Psychologie und Physiologie der Sinnesorgane
Zts. ration. Med.	Zeitschrift für rationelle Medicin
Zts. Reprodukt.	Zeitschrift für Reproduktionstechnik
Zts. Rübenzuckerind.	Neue Zeitschrift für Rübenzuckerindustrie
Zts. Schiess Spreng.	Zeitschrift für das gesammte Schiess- und Sprengstoffwesen
Zts. Spiritusind.	Zeitschrift für Spiritusindustrie
Zts. Telegr. Ver.	Zeitschrift des deutsch-österreichischen Telegraphen-Vereins
Zts. Thiermed.	Zeitschrift für Thiermedizin
Zts. Tuberkulose	Zeitschrift für Tuberkulose und Heilstättenwesen
Zts. Ver. deut. Ingen.	Zeitschrift des Vereins deutscher Ingenieure
Zts. Ver. Rübenzuckerind.	Zeitschrift des Vereins für die Rübenzucker-Industrie des deutschen Reichs
Zts. Ver. Zuckerind.	Zeitschrift des Vereins der deutschen Zuckerindustrie
Zts. Wiss. Geogr.	Zeitschrift für wissenschaftliche Geographie
Zts. wiss. Mikro.	Zeitschrift für wissenschaftliche Mikroskopie
Zts. wiss. Photochem.	Zeitschrift für wissenschaftliche Photographie, Photo-physik, und Photochemie
Zts. wiss. Zool.	Zeitschrift für wissenschaftliche Zoologie
Zts. Zuckerind.	Zeitschrift für Zuckerindustrie
Zts. Zuckerind. Bohm.	Zeitschrift für Zuckerindustrie in Böhmen
Zürich Denkschr. Med. Chir. Ges.	Denkschrift der medicinisch-chirurgischen Gesellschaft des Kantons Zürich
Zürich Mitth.	Mittheilungen der Naturforschenden Gesellschaft in Zürich
Zürich, Monats.	Monatsschrift des wissenschaftlichen Vereins in Zürich
Zürich naturf. Ges.	Vierteljahrschrift der naturforschenden Gesellschaft in Zürich
Zürich Physik. Ges. Jahr.	... Jahresbericht der physikalischen Gesellschaft in Zürich
Zürich, Schweiz. Ges. Neue Denkschr.	Neue Denkschriften der allgemeinen Schweizerischen Gesellschaft für die gesammten Naturwissenschaften
Zürich, Soc. Entom.	Societas Entomologica. Organ für den internationalen Entomologenverein. Zürich
Zürich, Unters. Physiol. Lab.	Untersuchungen aus dem Physiologischen Laboratorium der Züricher Hochschule
Zürich, Verh.	Verhandlungen der Medicinisch-chirurgischen Gesellschaft des Kanton Zürich im Jahr 1826
Zürich, Vierteljahrschr.	Vierteljahrschrift der Naturforschenden Gesellschaft in Zürich
Zwickau Ver. Naturk. Jahr	Jahresbericht des Vereins für Naturkunde zu Zwickau
Zwolle, Vooruitgang.	De Vooruitgang; Tijdschrift voor Wetenschap

CHAPTER XII.

HISTORICAL DEVELOPMENT OF THE CELLULOSE ESTERS.¹

The eleven preceding chapters in this volume have subdivided the subject of the Technology of Cellulose Esters roughly into three sections, of which the four chapters constituting Section One (pp. 1-664) are the raw materials cellulose, starch and cotton, and the preparation of the latter for esterification, while the second section comprehends the raw materials nitric acid, sulfuric acid, and mixed acids as used for the formation of the cellulose esters when combined with the products detailed in the first part, together with a series of specific gravity and other tables as explanatory of the data preceding them (pp. 665-1566). Having carried cellulose in Part One to the point of combining with acids to ester formation, and the acids in Part Two to the point of combining with the cellulose in Part One, the third section of the present volume, being chapters ten and eleven, discussed the theoretical aspects of the cellulose nitrate esters

1. For a resume of the earlier technical development of the cellulose nitrates, the following patents may be consulted: United States, 2775, 4874, 11213, 11376, 14300, 15336, 15341, 17651, 17949, 18338, 23771, 24575, 27572, 31461, 31657, 33018, 35652, 38122, 38144, 42295, 43716, 47677, 48231, 48231, 48239, 50082, 50083, 50359, 52503, 52659, 58223, 59888, 60571, 60573, 61368, 65267, 76221, 76765, 77304, 79261, 83893, 86710, 86841, 88228, 88254, 88260, 88633, 88634, 88947, 89253, 89254, 89582, 90765, 90766, 91233, 91235, 91341, 91377, 91378, 91393, 92452, 93086, 93594, 93757, 94454, 96132, 97454, 99068, 101175, 102798, 103209, 105338, 105823, 106725, 112370, 113055, 113272, 113735, 113736, 114242, 114945, 117542, 121522, 122962, 123122, 124510, 125635, 125979, 126575, 126698, 126780, 127656, 128416, 128450, 127807, 129217, 133229, 133736, 133737, 133969, 136439, 136735, 136823, 136953, 137110, 138254, 138333, 139589, 139738, 139589, 139738, 141351, 141654, 143772, 143865, 144794, 145403, 147588, 149216, 150722, 151918, 152147, 152752, 153196, 153939, 156352, 156353, 156354, 156355, 156358, 158188, 160010, 152232, 163221, 163939, 165234, 165303, 166922, 168497, 169053, 170360, 176548, 172482, 172486, 172995, 173647, 173865, 173999, 174000, 174001, 174002, 174525, 175735, 178479, 179688, 180133, 180666, 182431, 183550, 184510, 184481, 187593, 190363, 190865, 196884, 198985, 199908, 199908, 200914, 200939, 201348, 201910, 202441, 203834, 204227, 204228, 204229, 205271, 205836, 205880, 208854, 209570, 210441, 210611, 210612, 210780, 216474, 217111, 217232, 217474, 218122, 219218, 219235, 219279, 220386, 220435, 220502, 221070, 221977, 223311, 223736, 224682, 224745,

(1567-1932), their methods of manufacture (1933-2272) and the tests by which they may be recognized and standardized (2273-2375)—the latter being the preceding chapter.

The subject matter of this section is intended as a general epitome of the more important and noteworthy of the technical advances of the cellulose esters, in which the descriptive matter

224841, 225456, 225802, 227168, 227352, 228005, 229463, 229694, 230216, 230878, 231583, 232037, 232095, 232449, 233076, 233414, 233558, 233604, 233824, 233851, 233878, 233898, 233973, 234665, 234675, 234823, 235344, 235831, 235932, 235953, 235954, 235958, 235959, 236034, 236615, 236905, 237168, 237247, 237279, 237559, 237662, 237779, 238927, 239423, 239424, 239425, 239466, 239791, 239792, 239793, 239794, 241004, 241005, 242298, 242893, 243782, 245952, 246270, 246678, 246891, 247477, 247734, 248413, 249048, 249600, 251145, 251212, 251259, 251260, 251410, 251473, 251731, 251924, 251938, 252856, 253001, 253840, 253840, 253864, 254280, 254751, 255355, 255933, 256198, 256476, 256596, 256597, 256879, 257033, 257607, 258164, 258170, 258480, 258450, 258858, 259826, 259950, 262077, 264986, 264987, 264988, 265229, 265337, 265613, 265837, 266582, 267045, 267046, 267108, 269340, 269341, 269342, 269343, 269344, 269345, 270538, 271035, 271370, 271476, 271493, 271494, 271495, 271496, 271901, 272032, 272033, 274328, 274328, 274522, 275215, 271216, 275422, 276245, 276248, 276435, 276443, 276916, 276948, 277693, 277694, 277939, 278321, 278536, 278667, 279384, 280659, 280745, 281529, 282451, 282914, 283487, 283044, 283224, 283225, 284998, 284970, 285619, 286212, 286535, 286541, 286922, 288955, 289230, 289240, 289241, 289242, 289338, 289917, 290553, 291533, 293408, 294204, 294557, 294661, 296970, 296967, 296968, 296969, 297098, 297620, 297770, 297935, 298072, 299388, 299389, 299390, 299802, 299803, 299804, 299857, 300158, 300725, 301706, 301936, 301995, 302630, 302823, 304020, 304631, 304880, 306519, 307032, 307179, 307269, 308889, 309831, 310957, 311203, 313238, 315357, 315633, 317390, 318233, 319084, 320884, 322729, 322802, 322803, 322804, 322805, 326119, 326132, 327462, 328666, 328843, 329093, 329128, 329273, 329313, 330185, 330838, 331241, 331242, 331713, 333469, 334729, 334734, 335526, 335935, 336006, 336822, 337472, 338544, 339787, 340024, 341158, 341927, 342208, 342694, 343850, 343903, 344823, 345083, 345082, 345983, 346376, 346722, 347424, 348222, 349658, 349659, 349987, 350049, 350497, 350498, 350577, 351611, 352726, 352852, 353642, 353697, 350064, 356108, 358848, 359032, 360811, 361315, 362076, 363131, 363197, 363898, 365768, 366231, 366336, 366337, 366898, 368027, 368223, 368277, 368501, 368591, 369784, 370546, 371021, 371357, 372100, 373001, 374585, 375952, 376000, 377944, 379289, 380654, 381354, 383272, 381354, 383987, 384005, 384190, 385642, 385777, 385797, 386006, 386110, 386822, 386925, 387947, 388287, 392794, 393029, 393079, 393546, 393750, 393751, 393752, 393753, 394559, 397856, 398559, 401014, 401269, 401435, 405874, 406507, 407938, 408344, 408965, 409044, 409345, 409507, 410204, 410205, 410206, 410207, 410208, 410209, 410404, 410598, 411127, 412409, 412545, 413070, 415566, 416710, 417202, 417284, 417702, 417727, 418136, 418237, 418787, 419257, 419258, 419259, 419260, 419261, 419262, 419263, 420140, 420355, 420445, 420446, 420447, 420648, 421137, 421367, 421860, 422195, 422303, 422330, 423075, 423104, 423230, 423303, 425129, 425129, 425648, 425679, 425915, 426120, 426170, 426202, 426513, 427928, 427958, 428654, 429145, 429516, 429635, 429792, 429843, 430212, 430215, 430520, 432047, 434049, 434287, 434288, 434330, 436733, 436787, 437044, 437499, 438309, 438816, 439160, 439451, 440921, 441831, 443105, 443205, 443215.

is necessarily limited in endeavoring to encompass such a broad subject within the 707 pages constituting this chapter, but at the same time to include sufficient reference to the original repositories of information, that a seeker after additional knowledge may have at his disposal a sufficient number of indications of the development of any special section that he may be able

English Patents: 1407, 1846, 13296, 1850, 13713, 1851, 1638, 1854, 173, 283, 309, 320, 607, 745, 749, 770, 1420, 1765, 1876, 1914, 1920, 1974, 2112, 2139, 2358, 2359, 2636, 2771, 2802, 2808, 2849, 1855, 101, 231, 607, 634, 896, 1123, 1159, 1171, 1244, 1651, 1652, 1724, 1756, 1862, 2029, 2072, 2254, 2256, 2385, 2871, 1856, 498, 500, 624, 639, 653, 726, 965, 1511, 1843, 1883, 1884, 1908, 2315, 2882, 3027, 3066, 1857, 178, 468, 639, 1090, 1986, 2041, 2349, 2749, 2849, 2951, 3066, 1858, 49, 734, 945, 1255, 1978, 1651, 1744, 2293, 2295, 2789, 2790, 2791, 1859, 1295, 1454, 2249, 2384, 2775, 2881, 3024, 1860, 508, 955, 1074, 1089, 1936, 2140, 2661, 13542, 1861, 158, 320, 432, 556, 679, 852, 1000, 1403, 1712, 2072, 2598, 1862, 222, 282, 365, 1057, 1291, 2720, 2954, 3410, 1863, 446, 503, 756, 1001, 1060, 1774, 2033, 2100, 2143, 2190, 2347, 2465, 2675, 2953, 3018, 3164, 1864, 72, 97, 320, 449, 1102, 1300, 1313, 1552, 1791, 2542, 2733, 3163, 3190, 3253, 3359, 1865, 97, 953, 1564, 1592, 1695, 1746, 2418, 2695, 2709, 3002, 3293, 3301, 3325, 1866, 865, 989, 1002, 1216, 1695, 1816, 2666, 2785, 2816, 2923, 2968, 3127, 3157, 3458, 3542, 3652, 1867, 535, 536, 741, 1124, 1206, 1210, 1222, 1366, 1614, 1717, 2201, 2489, 2542, 3115, 3408, 3651, 3984, 1868, 689, 1603, 2022, 2510, 2249, 3102, 1869, 180, 787, 941, 959, 1017, 1626, 2101, 2649, 2867, 2892, 3373, 3617, 1870, 540, 1025, 1035, 1208, 1879, 2070, 2430, 2972, 3178, 3376, 1871, 970, 1443, 2625, 2693, 2772, 2848, 3101, 3103, 3447, 1872, 445, 1170, 1610, 1830, 2802, 3717, 4195, 1873, 1063, 1074, 1275, 2062, 2262, 3612, 3717, 3781, 1874, 718, 726, 827, 1025, 1276, 1739, 1825, 2044, 2059, 2275, 2459, 2513, 3088, 3766, 1875, 215, 1750, 2114, 2596, 2515, 2742, 3295, 3605, 4806, 1876, 142, 174, 198, 555, 954, 1008, 1601, 1877, 2312, 2468, 2768, 2832, 3222, 3294, 3613, 3685, 3703, 3715, 3760, 3986, 4447, 4771, 1877, 36, 185, 304, 759, 878, 1285, 2089, 2217, 2473, 2484, 2517, 2519, 2660, 2807, 2912, 3196, 3285, 3300, 3703, 3842, 4711, 4888, 4926, 5057, 5112, 5240, 5255, 1878, 127, 156, 226, 718, 748, 959, 1090, 1422, 1552, 1865, 1866, 2399, 2536, 2771, 3119, 3170, 3693, 4202, 4394, 5117, 5223, 1879, 163, 800, 847, 1077, 1112, 1284, 1294, 1569, 2242, 2162, 2322, 2326, 3352, 3400, 3474, 3753, 4200, 4230, 4874, 4933, 4933, 4913, 5341, 1880, 431, 800, 801, 814, 896, 983, 1341, 1476, 1477, 1480, 1559, 1728, 1811, 2057, 2226, 2483, 2985, 3072, 3376, 3485, 3628, 3864, 4896, 5522, 1881, 24, 220, 466, 567, 619, 775, 1553, 1433, 1461, 1816, 1849, 2073, 2517, 2943, 3072, 3176, 3749, 3750, 3889, 4458, 4917, 6152, 14009, 14413, 1882, 33, 441, 466, 983, 1608, 1765, 1767, 1893, 1960, 2326, 2481, 2517, 2984, 3103, 3362, 3615, 3662, 3866, 3930, 4128, 4154, 4589, 4765, 4917, 5554, 5722, 5845, 5898, 5978, 6074, 28969, 1883, 503, 1024, 1895, 1908, 2037, 2073, 2841, 3029, 3141, 3171, 3930, 3936, 4917, 5068, 5191, 5382, 5433, 6051, 7830, 8253, 8642, 9461, 10558, 10765, 10864, 10986, 11808, 12292, 13522, 14587, 15121, 15217, 16224, 16805, 17045, 1884, 491, 553, 1207, 1265, 1503, 1958, 2134, 2139, 2158, 2735, 3888, 4349, 4608, 4669, 5054, 5202, 5349, 5657, 6045, 6561, 6926, 7187, 7223, 7382, 7640, 7654, 7676, 8012, 8523, 8626, 8627, 8693, 8786, 8787, 8951, 8963, 9319, 11428, 11454, 11474, 11880, 12023, 12778, 12837, 15089, 15129, 15140, 15475, 15526, 15694, 15804, 15872, 1885, 1741, 1722, 2210, 2211, 3645, 3665, 4218, 4349, 4735, 4737, 5380, 5413, 5508, 5793, 6167, 6664, 7903, 7911, 8442, 9874, 10659, 10960, 11101, 11808, 12532, 12838, 13011, 13380, 13580, 14381, 14803, 15555, 15727, 15993, 16476, 1886, 383, 405, 448, 1443, 1870, 2109, 2123, 2318, 2628, 2694, 2695, 2770, 3027, 3530, 3880, 4833, 4915, 5080, 5152, 5586, 5791, 6022, 6389, 6870

to obtain a fairly comprehensive view of the subject without compelling him to resort to the detailed information in the other volumes of this series—unless he so desires.

The data in this chapter is divided for purposes of logical presentation into twelve sections and 290 sub-sections, as follows:

1. Cellulose ester solvents, non-solvents, diluents, high boil-

7376, 7377, 7608, 7738, 8253, 8387, 8442, 9659, 9910, 11281, 12111, 12521, 12534, 12743, 13084, 15771, 15772, 15773, 16155, 16380, 16783, 17167, 17506, 1887, 405, 487, 667, 1110, 1395, 1469, 1470, 1471, 1591, 1751, 1836, 2122, 2543, 3008, 3321, 3354, 4310, 4608, 5055, 5270, 5577, 6418, 6460, 6560, 6869, 6875, 7020, 7044, 8221, 9604, 9665, 9799, 10107, 10301, 10604, 11398, 11579, 11665, 13429, 13656, 14171, 14235, 15052, 15189, 16035, 16213, 16465, 17094, 17212, 17456, 17691, 18362, 1888, 246, 448, 851, 1115, 1445, 1471, 1988, 2570, 2571, 2661, 3591, 4477, 4479, 5344, 5503, 5614, 6103, 6399, 6740, 7715, 7716, 8428, 8513, 8718, 9267, 9879, 9361, 10376, 10393, 10428, 11344, 11664, 11665, 12046, 12111, 12307, 12309, 12338, 13486, 14569, 15782, 16238, 16708, 17020, 17236, 17496, 17999, 18016, 18060, 18214, 18727, 18730, 18868, 18990, 18896, 19897, 20104, 20524, 20665, 20964, 1889, 42, 376, 682, 683, 772, 1650, 1765, 1878, 1897, 2239, 2547, 3004, 3240, 3393, 3725, 3768, 3770, 3852, 4178, 4243, 5209, 5364, 5367, 5376, 5420, 5730, 6940, 7301, 8481, 8811, 8843, 9315, 9799, 9893, 9958, 10012, 10116, 10134, 10701, 11018, 11130, 11668, 11945, 12223, 12684, 12732, 13191, 13836, 13864, 14180, 14625, 14830, 15483, 15687, 15868, 15967, 16058, 16069, 16747, 16832, 17012, 17212, 17233, 17268, 17342, 18119, 18472, 18989, 19160, 19522, 19658, 19896, 20890, 20973, 20978, 21294, 22736, 1890.

French Patents, 7127, 7128, 7129, 18267, 41405, 59356, 69356, 71285, 71871, 74881, 76215, 85369, 86144, 86546, 86602, 88556, 88898, 89853, 90752, 91387, 91749, 97175, 105161, 110571, 115120, 117007, 125309, 129980, 132495, 141345, 144257, 146789, 147325, 151613, 153634, 155745, 162965, 165349, 167083, 171952, 172207, 172309, 177524, 184247, 184548, 185179, 186801, 192683, 194792, 194905, 195360, 195634, 195655, 195656, 198946, 199091, 199494, 199734, 200275, 201740, 201741, 203191, 203202, 203741, 207624, 208258, 208405, 208464, 208856, 208857.

German Patents, 22, 489, 690, 851, 890, 976, 1017, 1195, 1349, 1443, 1694, 1853, 2012, 2430, 2636, 2660, 2693, 2832, 3008, 3101, 3392, 3867, 4007, 4410, 4610, 4771, 4829, 4976, 5528, 6064, 6450, 6472, 6512, 6556, 6828, 6902, 6927, 7104, 7380, 7784, 7859, 8008, 8273, 8528, 8829, 9009, 9140, 9857, 9890, 10210, 10232, 10864, 11717, 11836, 12115, 12266, 12416, 12769, 12778, 13726, 13944, 14625, 14884, 15916, 16413, 17026, 17272, 17677, 17722, 18413, 18438, 18950, 19635, 20462, 20483, 20733, 21160, 21833, 21957, 22236, 22418, 23153, 23492, 23760, 23808, 23822, 24177, 24277, 24772, 24795, 25139, 25171, 25535, 25590, 25886, 26014, 26072, 27031, 27033, 27077, 27503, 27658, 27918, 27969, 28064, 28066, 28296, 28887, 28972, 28984, 29664, 29669, 30291, 30366, 30470, 30676, 30843, 30902, 31786, 31945, 32083, 32293, 32874, 32891, 33612, 34117, 35510, 36061, 36514, 36573, 36705, 36718, 36872, 37355, 37824, 37903, 38325, 38363, 38368, 37824, 38325, 38363, 38428, 38734, 39785, 40273, 40373, 41507, 41678, 42452, 42558, 42743, 42893, 43002, 43695, 44041, 44129, 45024, 45131, 45624, 45712, 45857, 46126, 46205, 46265, 48755, 48933, 49154, 49261, 49356, 50008, 50921, 51022, 51189, 51471, 51755, 52775, 52868, 52977, 53078, 53284, 53296, 53420, 53672, 53936, 54077, 54214, 54434, 54444, 54528, 54819, 55292, 55393, 55650, 55949, 56330, 56331, 56510, 56655, 56785, 56786, 56946, 57393, 57399, 57427, 57534, 57618, 57630, 57711, 57732, 58133, 58381, 58500, 58508, 59267, 59929, 60233, 60560, 60595.

ers, desensitizers, accelerators, activators, and the various direct, latent and ancillary solvents and solvent combinations for fluid mixtures and thermoplastic bodies (pp. 2382-2572).

2. Pyroxylin lacquers, bronzing liquids, waterproofing solutions, and in general, the fluid cellulose nitrate combinations used in the arts as protective coatings for rigid surfaces (2573-2599).

3. Artificial and imitation leather coatings, the application of the cellulose nitrates to textiles and paper in the formation of enameled, embossed and imitative leathers, wall paper and upholstery material (2599-2618).

4. The coating, filling, enameling and treating of leather, skins and feathers with nitrocellulose solutions, including grain, flesh and buff splits, in the formation of patent and enameled leather effects (2618-2621).

5. Artificial silk filaments of nitrocellulose, cuprammonium and other cellulose combinations (excluding viscose), the formation of imitation ribbon, straw and those processes which involve forcing a fluid cellulose combination through minute apertures into a coagulating media in the formation of filaments of indefinite extension (2621-2655).

6. The broad field of thermoplastic nitrocellulose combinations typified by celluloid and xylonite, and the various substitutes for these products which have been proposed from time to time (2655-2779).

7. Applications of nitrocellulose as celloidin and other cellulose ester preparations in general biological, histological and pathological technique (2779-2784).

8. The pharmaceutical, medicinal and surgical fields of cellulose nitrate application (2784-2795).

9. Pyroxylin in the multitudinous ramifications of the art of photography, including stereotype, reproduction technique and the details of the subject of continuous (moving) films (2795-2921).

10. Guncotton, smokeless powder, and the application of the cellulose nitrates to the warlike arts, including the blasting gelatins, gelignites and dynamites, and the other brisant combinations in which some form of nitrocellulose enters (2921-2986).

11. The alkyl and aryl cellulose ethers, and combinations with organic acid radicals, carbohydrate carboxylates, including the cellulose formates and acetates and ethyl cellulose (2987-3000).

12. Cellulose sulfocarbonates, and the general technical applications of the cellulose xanthates, including viscose artificial filaments (3062-3083).

Each of the above twelve sections is further subdivided into 290 separate topics by means of individual synoptical indices (see pages 2382, 2573, 2599, 2618, 2821, 2655, 2779, 2784, 2795, 2921, 2987, 3062, respectively), and beyond this the general indices are to be consulted. In the 12,473 separately numbered notes contained in this chapter, only the main references are intended to be indicated, the amplification of the several subjects being reserved for the succeeding volumes of this series.

Section One. Cellulose Ester Solvents, High Boilers and Plastifiers (pages 2382-2572). This general historical development of the fluids and solids used in nitrocellulose combinations is divided into:

1. Cellulose ester solvents (pp. 2382-2395); acetone and higher aliphatic ketones (2395-2401); diacetone alcohol (2401-2402).
2. Aliphatic alcohols, methyl (2402-2412), ethyl (2412-2428), propyl (2428-2437), butyl (2437-2446); amyl (2446-2469); fusel oil (2469-2486).
4. Alkyl esters of aliphatic mono-carboxylic acids. Amyl acetate (2486-2497); alkyl formates (2497-2499); acetates (2499-2506); propionates (2506-2507); butyrates (2507-2508); and valerianates (2508-2509).
5. Cellulose ester thermoplastic-inducing bodies. Camphor, natural (2510-2517); artificial (2517-2520); synthetic (2520-2535). Camphor substitutes (2535-2550). Proteid substitutes (2550-2551). Ureas (2551-2553).
6. Solvent recovery (2553-2558). Handling solvents (2558-2562).
7. Paint and varnish removers (2562-2568); turpentine substitutes (2568-2572).

Cellulose Ester Solvents. Immediately after the discovery of the cellulose nitrates experimenters directed their attention to extending its field of usefulness by means of solvents, alcohol and ether together being one of the earliest solvent combinations used in pharmacy and photography. A. Parkes employed in 1856 and subsequently, anhydrous wood alcohol and ditroben-

zene;¹ J. Lassaigne in 1848,² and H. Vohl the next year,³ published their work⁴ on the solubility of nitrocotton in ether; while B. Saillard⁴ worked on the dissolving power of alcohol and ether in connection with collodion pictures.

Amyl nitrate was described in 1848,⁵ and methyl and ethyl nitrates in 1862,⁶ methyl ether in 1864,⁷ and in 1867⁸ appeared the solvent combinations of D. Spill, consisting of dehydrated alcohol with essential oils, resins, spirits of turpentine, and coal tar naphthas. D. Blake⁹ also used alcohol. L. Stæcker combined alcohol, carbon disulfide and naphtha.¹⁰ All were endeavoring to obtain non-hygroscopic, anhydrous solvent combinations. J. and I. Hyatt¹¹ used camphor combined with pressure in 1870. R. Böttger worked with sodium sulphhydrate and stannite.¹²

C. Bardy in 1879¹³ combined methyl alcohol, acetone and

1. E. P. 2359, 1855; 1123, 1125, 1856, 2675, 1864, 1313, 3163, 1865, 1614, 1868.

2. J. Chim. Med. 1848, 541; abst. Dingl. Poly. 1848, **110**, 65.

3. Ann. 1849, **70**, 360, abst. Poly. Centr. 1849, 1464, Jahr. Chem. 1849, **2**, 472. See also E. Barbet, U. S. P. 1328258, 1920; abst. C. A. 1920, **14**, 746.

4. E. P. 444, 1859. Cf. M. Newton, U. S. P. 128416, 1872. See also F. Baker, J. C. S. 1912, **101**, 1409, viscosity of ether-alcohol mixtures.

5. P. Hoffmann, Ann. 1848, **68**, 332; J. prakt. Chem. 1848, **45**, 358; Compt. rend. 1848, **26**, 184; Ann. Chim. Phys. 1848, (3), **23**, 374, Jahr. Chem. 1847-1848, **1**, 699; Pharm. Centr. 1848, **19**, 256, 621. For properties of amyl nitrate see S. Henrichsen, Wied. Ann. Phys. 1888, **34**, 180, abst. Zts. physik. Chem. 1888, **2**, 548. R. Lowenherz, Ber. 1890, **23**, 2180; abst. Zts. physik. Chem. 1890, **6**, 382, 556. J. Bruhl, Zts. physik. Chem. 1895, **16**, 202, 216, J. prakt. Chem. 1894, **158**, 139. For the formation of amylesters, see also W. Nernst and C. Hohmann, Zts. physik. Chem. 1893, **11**, 352. D. Konowalow, Zts. physik. Chem. 1887, **1**, 63, 1888, **2**, 380. P. Guye and L. Chavanne, Compt. rend. 1894, **119**, 953; abst. Zts. physik. Chem. 1895, **17**, 179. P. Walden, Zts. physik. Chem. 1895, **17**, 720, 1896, **20**, 378, 573.

6. M. Lea, Amer. J. Sci. 1862, (2), **33**, 86, 227, 1875, (3), **10**, 22. P. Champion, Compt. rend. 1871, **73**, 571; abst. Zts. Chem. 1871, **7**, 469.

7. C. Tellier, E. P. 387, 1864.

8. D. Spill, E. P. 2666, 1867; 3984, 1868; 3102, 1869, 1739, 1875. U. S. P. 91377, 97454, 1869; 101175, 1870.

9. E. P. 3651, 1868; 1603, 2510, 1869.

10. U. S. P. 89254, 1869.

11. U. S. P. 105338, 1870.

12. Jahr. physik. Vercin's Frankfurt a/M. 1873; Tageblatt des Natur. Ver. zu Graz, 1875, 54; Deut. Ind. Ztg. 1873, 18; Wag. Jahr. 1873, **19**, 356, 1875, **21**, 533; Indbl. 1873, No. 1; Elsner, Chem. Tech. Mitth. 1872-1873, **22**, 231; Technologiste, 1874, No. 394; Amer. Chemist, 1874, **4**, 358; Jahr. Chem. 1873, **26**, 827; Bull. Soc. Chim. 1874, **21**, 140, Chem. News, 1874, **29**, 124; Chem. Centr. 1874, **45**, 374; 1875, **46**, 663; J. C. S. 1874, **27**, 192, 1078; Dingl. Poly. 1873, **209**, 315; Poly. Centr. 1873, **39**, 863; Prakt. Techniker, 1873, 148.

13. Phot. Corr. 1879, **16**, 177; abst. Chem. Tech. Rep. 1879, **12**, 11, 185; Phot. Archiv. **20**, 172. Pharm. Zts. Russ. 1879, 659; abst. Amer. J. Pharm. 1880, **52**, 88. As far back as 1859, E. Ollion employed acetic acid,

glacial acetic acid; while three years earlier,¹ T. Edison observed that chloral hydrate is a solvent of some forms of cellulose and cellulose derivatives. The "etherized oil" of D. d'Halluin² appeared in 1876. Schweizer's reagent was proposed in 1875,³ and camphor combined with sulfurous acid, carbon tetrachloride or naphtha in 1879.⁴ In the 70's appeared the work of H. Dernen⁵ and of C. Girard⁶ on alkyl nitrates. Mono-, di- and tri-nitro-benzenes and toluenes formed the series of solvents exploited by T. Petry and O. Fallenstein,⁷ and W. Wolff and M. v. Foerster,⁸ the J. Stevens solvent patents began to issue in 1882.⁹ That same year W. McCaine described the solvent capacity of essential oils of cassia and cinnamon.¹⁰ In 1881 C. Lockwood¹¹ disclosed the value of chloral as an adjunct to nitrocellulose.

In 1889 appeared the first of the R. Schüpphaus patents¹² for the use of propyl and butyl alcohols as solvents in conjunction with camphor. Additional patents were granted for the use of anthraquinone,¹³ isovaleric aldehyde, amylienedimethyl-, and amyliendiethyl-ethers,¹⁴ α -, or β -naphthol,¹⁵ mono-, di-, or tri-acetin,¹⁶ palmitin, stearone,¹⁷ glyceryl benzoate, benzochlorhydrin, dichlorhydrin, dichloracetin, benzomonacetin, benzodiacetin, oleo-acetin, dinitroacetin, mononitrodiaacetin,¹⁸ propyl or butyl ethers,

F. P. 41349, 1850; add. dated June 16, 1860.

1. Amer. Chemist, 1876, **7**, 127; abst. Jahr. Chem. 1876, **29**, 836; Chem. Tech. Rep. 1877, **16**, 1, 399.

2. E. P. 2515, 1876.

3. A. Neubauer, Zts. anal. Chem. 1875, **14**, 196; abst. Poly. Notiz. 1875, **30**, 255; Chem. Tech. Rep. 1875, **14**, 1, 299.

4. E. P. 1865, 1866, 1879; abst. J. A. C. S. 1880, **2**, 231. U. S. P. 265837, 1882; F. P. 132405; Belg. P. 56230. See also E. P. 975, 1861.

5. E. P. 4202, 1879.

6. Amer. J. Sci. 1875, (3), **9**, 391; abst. Bull. Soc. Chim. 1875, **23**, 63.

7. E. P. 10986, 1884; abst. J. S. C. I. 1885, **4**, 468, 509.

8. D. R. P. 23808, 1883; abst. J. S. C. I. 1883, **2**, 545; Wag. Jahr. 1883, **29**, 389.

9. U. S. P. 269341, 269342, 269343, 269344, 1882; 478543, 1892; 559823, 559824, 1896; 718670, 1903; abst. J. A. C. S. 1892, **14**, 289; J. S. C. I. 1903, **22**, 226; Mon. Sci. 1903, **59**, 163.

10. U. S. P. 262077, 1882.

11. U. S. P. 246891, 1881; abst. J. A. C. S. 1881, **3**, 166. For the production of chloral by a continuous process, see J. Besson, U. S. P. 774151, 1904.

12. U. S. P. 410204, 1889; abst. J. A. C. S. 1892, **14**, 46; J. Soc. Dyers Col. 1889, **5**, 167.

13. U. S. P. 410205, 1889; abst. J. Soc. Dyers Col. 1889, **5**, 167.

14. U. S. P. 410206, 1889; abst. J. Soc. Dyers Col. 1889, **5**, 167.

15. U. S. P. 410207, 1889; abst. J. Soc. Dyers Col. 1889, **5**, 167.

16. U. S. P. 410208, 1889; abst. J. Soc. Dyers Col. 1889, **5**, 167.

17. U. S. P. 410209, 1889; abst. J. Soc. Dyers Col. 1889, **5**, 167.

18. U. S. P. 598648, 1898; abst. J. Soc. Dyers Col. 1898, **14**, 118.

anisol, phenetol, guaiacol, naphthylethyl ether,¹ methylisobutyl-, ethylisobutyl-, ethylisoamyl-, ethylisopropyl-, propylamyl-, propylbutyl-, and butylamyl ethers.²

During the period 1885-1889 appeared isoamyl nitrate,³ chloramyl chloracetate,⁴ chloramyl alcohol,⁵ amyl chloride and chloracetate,⁶ dammar, guaiac, mastic,⁷ nitrobenzene and dinitrotoluene,⁸ a mixture of ethyl and amyl alcohol,⁹ amyl acetate,¹¹ dimethylacetal, ethylmethylacetal, metacetone,¹² and "salubrine" (ethyl acetate, alcohol and acetic acid).¹³

The next five-year period witnessed the publication of solvent ester processes involving the employment, among other chemicals, of methyl ethyl, propyl and methylethyl ethers,¹⁴ methyl and amyl acetates distilled together,¹⁵ methylated spirit,¹⁶ eugenol-benzyl ether,¹⁷ valeraldehyde,¹⁸ butyl formate and amyl acetate,¹⁹ amyl-ethyl acetate,²⁰ propylmethyl ketone,²¹ methyl alcohol and

1. U. S. P. 600556, 1898.
2. U. S. P. 741554, 1903; abst. J. S. C. I. 1903, **22**, 1254. See also A. Bertrand, J. A. C. S. 1880, **2**, 434; abst. Bull. Soc. Chim. 1880, **33**, 566.
3. Mierzinsky, *Erfind u. Erfahr.* 1880, **7**, 540.
4. E. Liebert, U. S. P. 413070, 1889; E. P. 5503, 1889; D. R. P. 51022, 1889; F. P. 199148; abst. *Wag. Jahr.* 1890, **36**, 540.
5. A. Orr, E. P. 487, 1888; abst. J. S. C. I. 1889, **8**, 204.
6. T. Craddock and J. Thom, D. R. P. 54554, 1888; abst. *Ber.* 1891, **24**, 133.
7. O. Amend, U. S. P. 371021, 1887; Re. 10879; 372100; abst. *Chem. Tech. Rep.* 1887, **26**, II, 280; *Chem. Ztg.* 1887, **11**, 1432.
8. J. Jarvis, U. S. P. 329313, 1885; abst. J. A. C. S. 1885, **7**, 254.
9. J. Sayers, E. P. 17212, 1888; abst. J. S. C. I. 1889, **8**, 1009.
10. A. Cronquist and C. Lundholm, E. P. 15993, 1886; abst. J. S. C. I. 1887, **6**, 691.
11. Doutrelepon, F. P. 189947, 1888, abst. *Mon. Sci.* 1888, **32**, 1397. See Doutrelepon, D. R. P. 27969, 1883; 45857, 1888.
12. F. Greening, E. P. 5344, 1889; abst. J. S. C. I. 1890, **9**, 522.
13. G. Michaelis and W. Mayer, E. P. 8523, 1885, D. R. P. 36514, 1885.
14. P. Hakansson, E. P. 10465, 1893; abst. J. S. C. I. 1893, **12**, 562.
15. F. Krafft and A. Ross, U. S. P. 516766, 1894; E. P. 21938, 1892; abst. J. S. C. I. 1893, **12**, 200, 464. For the properties of amyl ether, see *Chem. Centr.* 1875, **46**, 611; 1897, **68**, II, 246; 1908, **79**, II, 392. See G. Schroeter and W. Sondag, D. R. P. 200150, 1907; *Ber.* 1908, **41**, 1921; abst. *Chem. Zentr.* 1908, **79**, II, 495, 551.
16. L. Paget, U. S. P. 494790, 494791, 494792, 494793, 507749, 1893; E. P. 7784, 22137, 1893; abst. J. S. C. I. 1893, **12**, 701; 1894, **13**, 263.
17. W. Bolton, *Brit. J. Phot.* 1891, **38**, 627, 771. C. King and R. Jellicoe, E. P. 15686, 1893.
18. F. Ach, U. S. P. 487167, 1892; abst. J. A. C. S. 1892, **14**, 390; J. Soc. Dyers Color. 1893, **9**, 50.
19. G. Zeller, U. S. P. 518386, 518387, 1894.
20. G. Zeller, U. S. P. 518388, 1894.
21. G. Zeller, U. S. P. 555596, 1896.
22. W. Ramsay and J. Shields, *Zts. physik. Chem.* 1893, **12**, 466, 475.
23. P. Thorpe and L. Jones, *Zts. physik. Chem.* 1893, **11**, 840; abst. J. C. S.

nitroglycerol,¹ ethyl nitrate with nitrobenzene,² ethyl acetate and nitrobenzene,³ acetone oil.⁴ A. Nobel⁵ has described a compre-

1893, **64**, 272. Thomsen, Zts. physik. Chem. 1890, **6**, 349. C. Thwig, Zts. physik. Chem. 1894, **14**, 293.

1. S. Smolianinoff, E. P. 11018, 1890; abst. J. S. C. I. 1890, **9**, 840.

2. California Explosive Co., E. P. 11326, 11326-A, 1891; abst. J. S. C. I. 1891, **10**, 1029.

3. W. Wolff and M. von Forster, E. P. 3896, 1894. See R. Gnehm, U. S. P. 361690, 1887; abst. J. A. C. S. 1887, **9**, 106.

4. F. Crane, E. P. 6513, 1892; abst. J. S. C. I. 1893, **12**, 200.

5. E. P. 4479, 1889, 15914, 1894. See also E. P. 20234, 1893; abst. J. S. C. I. 1894, **13**, 921, 1008, 1072, 1895, **14**, 787, 814. E. P. 14231, 1901; abst. J. S. C. I. 1902, **21**, 1033. For preparation of ethyl lactate see Chem Werke vorm. Dr. H. Byk, E. P. 458615, 1913; abst. J. S. C. I. 1913, **32**, 1086, Kunst 1914, **4**, 358.

The preparation and properties of ethyl salicylate are described in the publication of F. Raoult, Compt. rend. 1888, **107**, 442; abst. Zts. physik. Chem. 1888, **2**, 853. F. Stohmann, Zts. physik. Chem. 1888, **2**, 34; J. prakt. Chem. 1887, **144**, 364. Zts. physik. Chem. 1890, **6**, 351. B. von Schneider, Zts. physik. Chem. 1896, **19**, 158; 1897, **22**, 233. W. Perkin, Zts. physik. Chem. 1896, **21**, 627. P. Drude, Zts. physik. Chem. 1897, **23**, 311.

For certain properties of *i*-butyl nitrite see W. Perkin, Chem. News, 1889, **59**, 247; abst. Zts. physik. Chem. 1889, **4**, 479. J. Thomsen, Zts. physik. Chem. 1890, **6**, 352. R. Lowenherz, Zts. physik. Chem. 1890, **6**, 558. J. Bruhl, Zts. physik. Chem. 1895, **16**, 200, 214, 220.

i-Butyl nitrate is described by W. Perkin, Chem. News, 1889, **59**, 247; abst. Zts. physik. Chem. 1889, **4**, 479. R. Lowenherz, Zts. physik. Chem. 1890, **6**, 552, 556; Ber. 1890, **23**, 2180. J. Bruhl, Zts. physik. Chem. 1895, **16**, 200, 214, 220.

i-Butyl benzoate has engaged the attention of F. Stohmann, Zts. physik. Chem. 1888, **2**, 33, 1890, **6**, 352. W. Perkin, Zts. physik. Chem. 1896, **21**, 578, 579. P. Drude, Zts. physik. Chem. 1897, **23**, 308.

For information on propyl nitrite consult R. Lowenherz, Zts. physik. Chem. 1890, **6**, 558, abst. J. C. S. 1884, **45**, 241; Ber. 1890, **23**, 12, 2180. J. Bruhl, Zts. physik. Chem. 1895, **16**, 214, 220.

See also, propyl nitrate, W. Perkin, Zts. physik. Chem. 1889, **4**, 479, Chem. News, 1889, **59**, 247. R. Lowenherz, Ber. 1890, **23**, 2180; abst. Zts. physik. Chem. 1890, **6**, 382, 556. J. Bruhl, Zts. physik. Chem. 1895, **16**, 214; J. prakt. Chem. 1894, **158**, 139, Ber. 1891, **24**, 2452. For propyl borate, see E. Khotinsky and M. Melamed, Ber. 1909, **42**, 3090; abst. Chem. Zentr. 1909, **80**, II, 1210.

Amyl chloride, F. Krit, Christ. Vid. Selsk. 1882, No. 20; abst. Beibl. Phys. 1883, **7**, 350; Zts. physik. Chem. 1891, **7**, 612. O. Humburg, Zts. physik. Chem. 1893, **12**, 413. H. Jahn and G. Moller, Zts. physik. Chem. 1894, **13**, 387, 388; cf. H. Landolt and H. Jahn, Zts. physik. Chem. **10**, 289. M. Berthelot, Zts. physik. Chem. 1899, **30**, 48. Amyl nitrite, S. Henriksen, Zts. physik. Chem. 1888, **2**, 548; Wied. Ann. Phys. 1888, **34**, 180. J. Thomsen, Zts. physik. Chem. 1890, **6**, 352. J. Gladstone, Zts. physik. Chem. 1890, **6**, 558; J. C. S. 1884, **45**, 241. R. Lowenherz, Zts. physik. Chem. 1890, **6**, 558. J. Bruhl, Zts. physik. Chem. 1895, **16**, 202, 216, 222. F. Taylor, J. Amer. Pharm. Assoc. 1914, **3**, 1327, 1466, 1584; abst. C. A. 1915, **5**, 235. Amyl-acetic acid, P. Walden, Zts. physik. Chem. 1894, **15**, 642.

Amyl borate, A. Ghira, Zts. physik. Chem. 1893, **12**, 764. Amyl chlor acetate, P. Walden, Zts. physik. Chem. 1894, **15**, 645. Amyl butyrate, Zts. physik. Chem. 1894, **15**, 644; 1896, **20**, 573. Amyl benzoate, F. Stohmann Zts. physik. Chem. 1888, **2**, 33; Zts. physik. Chem. 1890, **6**, 352. Amyl

hensive series of pyroxylin solvents, including the methyl, ethyl, propyl, butyl and amyl esters of oxalic, lactic, tartaric, citric, succinic, benzoic, hippuric, toluic, mesitylenic, salicylic and phthalic acids; chlor- and brom- derivatives of nitrobenzene, nitrotoluene, nitroxylenes, nitrocumene and nitrocymene; glyceryl acetate, benzoate and hippurate; the nitro-, chloro-, bromo-, chloro-nitro- and bromonitro- derivatives of the 55 esters above mentioned, and ethers of nitrophenols; ethyl and methyl nitrates,¹ nitromethyl acetanilid,² ethylnaphthyl ether, ethyl and amyl phthalates, phenanthrene,³ phenylbenzyl ether. E. Todd patented a mixture of fusel oil, benzine and acetic acid distilled together,⁴ and A. Sehr a series of ketones, including propione, butyrone, valerone, caprone, methylethyl, methylvaleral, acetylethyl, methylpropyl, methylbutyl, ethylbutyl and methylamyl ketones. The latter rapidly decrease in solvent power with increase in molecular weight.⁵

In the quinquennial period 1895-1899, the solvent art was exceedingly active, as witnessed by the disclosure of new dissolving bodies in conjunction with nitrocotton especially, and to a much more restricted degree with the cellulose acetates. Among those proposed during this period may be mentioned, dimethyl ether,⁶ benzyl salicylate,⁷ phenol and naphthol phosphates,⁸ dichlorhydrin, ethylene dichloride, trichloride and tetrachloride, tetrachlorethane,⁹ benzyl alcohol and benzoate,¹⁰ epichlorhydrin,¹¹

succinate, R. Schiff, Zts. physik. Chem. 1887, **1**, 382, Ann. 1886, **234**, 300; P. Walden, Zts. physik. Chem. 1896, **20**, 575.

¹ E. P. 2359, 1863.

² F. P. 470041, 470042, 1914, abst. Mon. Sci. 1916, **83**, 68.

³ G. Spica, Zts. Schuess Spreng. 1912, **7**, 129, abst. C. A. 1913, **7**, 700.

⁴ U. S. P. 450264, 1891, abst. J. A. C. S. 1891, **13**, 119. See also M.

⁵ Granger, F. P. 469490, 1914; J. S. C. I. 1915, **34**, 20.

⁶ U. S. P. 470451, 1892; abst. Chem. Tech. Rep. 1892, **16**, 224.

⁷ Act. Ges. Anilin Fabr., E. P. 25735, 1899, abst. J. S. C. I. 1900, **19**, 95, 954, 1037.

⁸ Act. Ges. Anilin Fabr., E. P. 7020, 1899, abst. J. S. C. I. 1900, **19**, 273, J. Soc. Dyers Col. 1900, **16**, 62.

⁹ Act. Ges. Anilin Fabr., E. P. 1154, 1912, F. P. 439067, 1912, abst. J. S. C. I. 1912, **31**, 604, 1147.

¹⁰ Act. Ges. Anilin Fabr., E. P. 17953, 1913, F. P. 461034, 1913; Belg. P. 259073; abst. Kunst. 1914, **4**, 236. For résumé of technical applications of tetrachlorethane containing 33 patent and 98 literature references, see E. Worden and L. Rutstein, Kunst. 1913, **3**, 83, abst. C. A. 1913, **7**, 4049.

¹¹ Act. Ges. Anilin Fabr., E. P. 17523, 17531, 1913; R. P. 268626, 269475; abst. C. A. 1914, **8**, 1860, 2041; 1915, **9**, 387. See also Anon., Rep. Lab. Am. Med. Assoc. 1918, **11**, 59; abst. C. A. 1919, **13**, 2107, J. S. C. I.

amyl-lactic acid,¹ methyl alcohol and methyl ether,² or purified ethyl ether,³ ethyl alcohol in conjunction with oxalic, citric, tartaric, lactic or levulinic acid, or of their potassium, sodium, ammonium, magnesium, calcium, strontium, barium, aluminium or zinc salts.⁴ The Soc. Chimique des Usines du Rhone have described methyl acetyl salicylate,⁵ phenylethyl, *p*-tolylethyl, *p*-methoxyphenyl-ethyl, and 6-methoxy-*m*-tolylethyl alcohols,⁶ and methyl and ethyl chlorides.⁷ R. Strehlenert has protected formaldehyde, acetaldehyde, paraldehyde and benzaldehyde;⁸ G. Walker has described the uses of "decreosoted oil of tar,"⁹ while G. Benjamin¹⁰ points out the advantages of diethyl ether, A. Behal¹¹ has described the formates of isopropyl, isobutyl, isoamyl, hexyl and heptyl.

From 1900 to 1904 inclusive, investigators—as a generality—

1919, **38**, 229-R. U. S. P. 563975, 1896.

11. H. Flemming, E. P. 8915, 1895; D. R. P. 84146, 91819; abst. Chem. Tech. Rep. 1895, **34**, II, 155. Chem. Ztg. 1895, **19**, 1550; abst. J. C. S. 1896, **70**, i, 333. Must. Ztg. 1897, **46**, 313; Arms and Expl. 1898, **6**, 65; J. C. S. 1898, **72**, i, 396. Pharm. Centr. 1903, **45**, 749; Jahr. Chem. 1904, **57**, 1168; Wag. Jahr. 1904, **50**, II, 512. See also F. Valenta, Photo. Corr. 1899, **36**, 333. Chem. Ztg. 1905, **29**, 807; abst. J. S. C. I. 1905, **24**, 933.

1. P. Guye and C. Goudet, Compt. rend. 1895, **121**, 827; abst. J. C. S. 1896, **70**, ii, 134.

2. G. Michaelis, U. S. P. 550017, 1896. Phot. Wochenbl. 1896, **22**, 185; Chem. Ztg. Rep. 1896, **20**, 200.

3. G. Michaelis, U. S. P. 1189602, 1916; abst. C. A. 1916, **10**, 2125; J. S. C. I. 1916, **35**, 907. Can. P. 173128, 1916; abst. C. A. 1918, **12**, 155. For other processes for the production of ether see J. Senderens, J. C. S. 1909, **96**, i, 127. O. Meyer, U. S. P. 749078, 1904. Elektrizitätswerk Lonza, D. R. P. 317589, 1918; abst. J. S. C. I. 1920, **39**, 427-A; Chem. Zentr. 1920, **91**, II, 445; J. C. S. 1920, **118**, i, 363. C. Claessen, D. R. P. 298822, 1915; abst. J. S. C. I. 1920, **39**, 312-A. Chem. Werke vorm. Dr. Heinrich Byk, D. R. P. Anm. C-20161, 20741, 1910. See also Anon., Chem. Ztg. 1919, **43**, 899; abst. C. A. 1920, **14**, 1622. Zts. Schiess. Spreng. 1908, **3**, 235; abst. C. A. 1909, **3**, 836.

4. E. Bronnert, E. P. 6858, 1896. The patents of P. Schlumberger (D. R. P. 93009; abst. Wag. Jahr. 1897, **43**, 1103; Chem. Centr. 1897, **68**, II, 928. Belg. P. 128822, 1897. Pharm. Centr. 1897, **28**, 722; Proc. Amer. Pharm. Assoc. 1898, **46**, 1026; Neues Erfind. Erfahr. 1898, **25**, 75) are similar.

5. E. P. 14699, 1902; abst. J. S. C. I. 1903, **22**, 880.

6. E. P. 122630, 1919; abst. C. A. 1919, **13**, 1715; J. S. C. I. 1919, **38**, 610-A; J. C. S. 1919, **116**, i, 483.

7. U. S. P. 628463, 1899; E. P. 25779, 1896. In this connection see F. Bayer & Co., Pharm. Ztg. 1893, 262; abst. Meyer Jahr. Chem. 1893, **1**, 249.

8. E. P. 22540, 1896; abst. Chem. Ztg. 1898, **22**, 212; Mon. Sci. 1905, **63**, 323; J. S. C. I. 1896, **15**, 784; 1897, **16**, 782, 907.

9. U. S. P. 604181, 1898; abst. J. Soc. Dyers Color. 1898, **14**, 182.

10. U. S. P. 662585, 1900; 677012, 1901; abst. Mon. Sci. 1901, **57**, 284.

* E. P. 14233, 1899; abst. J. S. C. I. 1902, **21**, 364.

11. U. S. P. 648580; E. P. 12157, 1899; F. P. 289130; D. R. P. 115334; Belg. P. 143163, 1899.

focussed their attention upon the study of solvents wherein the price, volatility, non-toxicity and solvent capacity were such as could compete favorably with the high boilers (as amyl acetate) or low boilers (as acetone). Many useful solvent combinations were obtained, and our knowledge of solvents materially extended. Among those which were described during this period, may be chronicled the "borobenol" of B. Borzykowski,¹ pinacone,² ethyl triacetyl gallate (etglen),³ tetranitromethane,⁴ 1:3-butylene glycol,⁵ benzyl isovalerate,⁶ epichlorhydrin,⁷ as described by F. Bayer & Co., while C. Claessen has indicated the utility of ethylidene diacetate,⁸ di- and poly-glycerols,⁹ and nitromethane and homologues.¹⁰

The C. Borgmeyer patents encompassed the use of lemon-grass oil,¹¹ oils of cedar leaf, bitter almonds, rue and pimento;¹² artificial cassia,¹³ caraway chaff,¹⁴ clove buds,¹⁵ and tansy, pepper-mint, red thyme and sassafras.¹⁶ Dinitrotoluene,¹⁷ ethyl borosalicylate (boryl),¹⁸ acetylene in acetone,¹⁹ ethyl butyrate in com-

1. Said to consist of 90% benzol, some phenol and an ester which does not contain a product obtained from acetate of lime.

2. F. Bayer & Co., E. P. 22795, 1911. D. R. P. 252759, 306523, 1917; abst. J. S. C. I. 1919, **38**, 158-A.

3. F. Bayer & Co., D. R. P. 279958; abst. Wag. Jahr. 1914, **60**, II, 128; Chem. Zentr. 1914, **85**, II, 1253.

4. F. Bayer & Co., E. P. 24299, 1909; abst. J. S. C. I. 1910, **29**, 840. C. Claessen, D. R. P. 184229, 1905; abst. J. S. C. I. 1908, **27**, 183.

5. E. P. 940, 1913; abst. Chem. Ztg. Rep. 1913, **37**, 387; J. S. C. I. 1913, **32**, 550.

6. D. R. P. 165897, 1904; abst. J. S. C. I. 1906, **25**, 443; Wag. Jahr. 1905, **51**, I, 97; Chem. Centr. 1906, **77**, I, 512; Chem. Ztg. 1906, **30**, 6; Zts. ang. Chem. 1906, **19**, 583; Jahr. Chem. 1905-1908, II, 371.

7. D. R. P. 239077, 1910; abst. C. A. 1912, **6**, 2143; J. S. C. I. 1911, **30**, 1409; Zts. ang. Chem. 1912, **24**, 2132; Chem. Zentr. 1911, **82**, II, 1393; Chem. Tech. Rep. 1911, **35**, 506. D. R. Ann. F-30410, 1910.

8. D. R. P. 172966, 174259, 1904; abst. Chem. Centr. 1906, **77**, II, 1631.

9. E. P. 9572, 1909; abst. J. S. C. I. 1908, **27**, 958.

10. D. R. P. 184229; abst. Jahr. Chem. 1905-1908, II, 160; Wag. Jahr. 1907, **53**, II, 34; Chem. Zentr. 1907, **78**, II, 366; Chem. Ztg. Rep. 1907, **31**, 267; Zts. ang. Chem. 1907, **20**, 1194; 1908, **21**, 214; Zts. Schiess. Spreng. 1907, **2**, 195; Mon. Sci. 1909, **71**, 71.

11. U. S. P. 502546, 1893; abst. J. A. C. S. 1893, **15**, 477.

12. U. S. P. 502547, 1893; abst. J. A. C. S. 1893, **15**, 447.

13. U. S. P. 502921, 1893; abst. J. A. C. S. 1893, **15**, 477.

14. U. S. P. 503401, 1893; abst. J. A. C. S. 1893, **15**, 477.

15. U. S. P. 503402, 1893; abst. J. A. C. S. 1893, **15**, 477.

16. U. S. P. 504905, 1893; abst. J. A. C. S. 1893, **15**, 593.

17. F. Jones, E. P. 18161, 1901; abst. Chem. Ztg. 1903, **27**, 40; Mon. Sci. 1904, **61**, 64; J. S. C. I. 1902, **21**, 1097.

18. Monteil, L'Union Pharm. 1908, **49**, 55; abst. J. S. C. I. 1908, **27**, 354.

19. K. Kaiser, D. R. P. 144846, 1902; abst. Chem. Centr. 1903, **74**, II, 924.

bination.¹ I. Kitsee,² proposes to dissolve nitrocotton by solvents in the vapor form.

In the five-year period of 1905-1909 activity in this art materially diminished, as indicated by the literature. The more meritorious suggestions recorded include the nitroformins and nitroacetins,³ menthyl borate (estoral),⁴ nitrated solvent naphtha,⁵ glyceryl salicylate,⁶ aluminium chloride,⁷ *m*-cresyl acetate,⁸ phenyl acetate,⁹ or benzoate,¹⁰ or di- and epi-chlorhydrins.¹¹ The du Pont Co., through their chemists, have disclosed the usefulness of aldols (as acetaldo),¹² amylene diacetate and benzene,¹³ butylene glycol¹⁴ and the nitrate,¹⁵ mesityl oxide,¹⁶ anisol,¹⁷ chlorohydrocar-

1. J. Miller, U. S. P. 725002, 1903, abst. Mon. Sci. 1903, **59**, 169; J. A. C. S. 1903, **25R**, 520.

2. U. S. P. 767913, 767914, 1904, abst. J. S. C. I. 1904, **23**, 880.

3. V. Vender, U. S. P. 946294, 1910. E. P. 9791, 1906, F. P. 372267, 1906, abst. C. A. 1909, **3**, 249, J. S. C. I. 1907, **26**, 553. E. P. 18279, 1909, D. R. P. 226422, 1906, abst. C. A. 1911, **5**, 993, 1517, Chem. Zentr. 1910, **81**, II, 1264; Jahr. Chem. 1910, **63**, 426, Wag. Jahr. 1910, **56**, I, 490. D. R. P. 209943, 1906, abst. J. S. C. I. 1909, **28**, 675; Chem. Zentr. 1909, **80**, I, 1839; Zts. ang. Chem. 1909, **22**, 1614, Wag. Jahr. 1909, **55**, II, 540, Chem. Ind. 1909, **32**, 315.

4. H. Thron, U. S. P. 841738, 1907, abst. Mon. Sci. 1907, **67**, 114; Chem. Ztg. Rep. 1907, **31**, 115, C. A. 1907, **1**, 768, 795.

5. G. Schultz, U. S. P. 898144, 1908; abst. C. A. 1909, **3**, 358.

6. C. Sorder, F. P. 373854, 1907, abst. J. S. C. I. 1907, **26**, 778.

7. J. Sauverzac, F. P. 402950, 1908; 420086, 1909, abst. J. S. C. I. 1909, **28**, 1310. In this connection see E. P. 1858, 1896, abst. J. S. C. I. 1897, **16**, 335.

8. N. Sulzberger, U. S. P. 932647, 1909, 949131, 1910, 1031971, 1912, abst. C. A. 1909, **3**, 2616, J. S. C. I. 1909, **28**, 1063.

9. R. Riddle, U. S. P. 797373, 1905, abst. J. S. C. I. 1905, **24**, 983.

10. H. Matheson, U. S. P. 1161063, 1915.

11. Kraemer & Elsbarg, and G. Kraemer, E. P. 26201, 1905. Commercial Research Co., E. P. 113954, 113955, 1918, abst. C. A. 1918, **12**, 1469.

12. U. S. P. 1008333, 1911, 1082573, 1913, 1086048, 1086381, 1914; 1151113, 1915, 1234921, 1917, E. P. 17259, 1911, 22622, 29964, 1913; 879, 1913, F. P. 149605, 449606, 449607, 1912; 453406, 1913, Can. P. 147423, Belg. P. 250115, 250116, 250117, 250118, 1912, Swiss P. 63136, 63137, abst. C. A. 1913, **7**, 2096, 3196, 1914, **8**, 210, 992, 1190, J. S. C. I. 1913, **32**, 507, 1129; 1914, **33**, 278, 374, 375, 1917, **36**, 1044, Kunst. 1914, **4**, 35, 154, 174. See also Konsortium f. Elektrochem. Ind., E. P. 19463, 26825, 1913; F. P. 461734, 1913, abst. J. S. C. I. 1914, **33**, 221, 219, Belg. P. 262208, 1913. R. Earle and L. Kyriakides, U. S. P. 1094314, 1914; abst. Kunst. 1914, **4**, 318. N. Grunstein, U. S. P. 1231156, 1917, E. P. 101636, 1916; abst. J. S. C. I. 1917, **36**, 1064. H. Hibbert, U. S. P. 1261811; abst. C. A. 1918, **12**, 1558.

13. U. S. P. 1084702, 1914; abst. C. A. 1914, **8**, 1010; Mon. Sci. 1914, **81**, 105.

14. U. S. P. 964842, 1911, abst. C. A. 1911, **5**, 2724.

15. E. P. 4099, 1911; abst. J. S. C. I. 1911, **30**, 836.

16. E. P. 5408, 1914; abst. J. S. C. I. 1914, **33**, 984.

17. U. S. P. 797024, 1905; abst. J. S. C. I. 1905, **24**, 985. See also G. Ferguson, U. S. P. 1270393, 1918.

bons with methyl alcohol and benzene,¹ alcohol, benzene and amyl acetate,² acetylating reduced acetone oil,³ butyrone⁴ and purified ether.⁵

Methyl, ethyl, propyl, palmitate, stearate, oleate, ricinoleate and linoleate, in the hands of the Soc. anon. Nouvelle "T'oyon-nithe,"⁶ glyceryl formate (formin),⁷ benzyl benzoate,⁸ glyceryl triacetate (triacetin),⁹ methyl acetol,¹⁰ monochlorhydrin,¹¹ dichlor-ethylene,¹² lactic acid and strontium lactate,¹³ thymyl trichloracet-ate,¹⁴ and cyclohexanone compounds.¹⁵ Santalol allophenate is efficient, but too expensive.¹⁶ P. Winand,¹⁷ E. Fischer,¹⁸ R.

1. U. S. P. 1082453, 1913, abst. J. S. C. I., 1914, **33**, 219, C. A. 1914, **8**, 821. Can. P. 147735, 1913; abst. C. A. 1913, **7**, 3196.

2. U. S. P. 1266073, 1918, E. P. 122456, 1918, abst. J. S. C. I. 1918, **37**, 461-A.

3. U. S. P. 1158217, 1915, abst. C. A. 1915, **9**, 3363.

4. U. S. P. 1283183, 1916, abst. J. S. C. I. 1919, **38**, 91-A, C. A. 1918, **12**, 187.

5. U. S. P. 1312475, 1919, C. A. 1919, **13**, 2575, J. S. C. I. 1919, **38**, 740-A. E. P. Appl. 17082, 1919; abst. J. S. C. I. 1919, **38**, 517-A.

6. F. P. 387179, 1908, abst. C. A. 1909, **3**, 1819.

7. Nitritfabrik Akt. Ges., E. P. 28723, 1907, abst. J. S. C. I. 1908, **27**, 356.

8. W. Lindsay, U. S. P. 961360, 1910, 1027617, 1027618, 1912, 1203756, abst. J. S. C. I. 1910, **29**, 875, 1912, **31**, 581. E. P. 13692, 1910. F. P. 416843, abst. Kunst. 1911, **1**, 73.

9. E. Gramer and E. Froger-Delapierre, E. P. 6183, 1906, abst. J. S. C. I. 1907, **26**, 59. H. Findeisen, E. P. 28591, 1906.

10. E. Huwart, E. P. 383555, 1907, abst. C. A. 1909, **3**, 1094, Mon. Sci. 1908, **68**, 166.

11. F. Heyer, U. S. P. 1040323, 1912, abst. J. S. C. I. 1912, **31**, 1054. Deutsche Sprengstoff Aktiengesellschaft, D. R. P. 201230, 220536, abst. J. S. C. I. 1911, **30**, 307. F. P. 370224, 370249, 1906, abst. J. S. C. I. 1907, **26**, 278.

12. Chemische Fabrik Griesheim-Elektron, U. S. P. 1084581, 1914, E. P. 23073, 1910, 16620, 1912, 14246, 1913, F. P. 446263, 1913, 474086, 1914, D. R. P. 254069, 1911, 271381, abst. J. S. C. I. 1913, **32**, 212, 213, 842, 1914, **33**, 219, 767, 1915, **34**, 724, C. A. 1913, **7**, 869, J. C. S. 1914, **106**, 1045. Belg. P. 259551, 1913.

13. B. Buchstab, D. R. P. 214398, 1909, abst. Wag. Jahr. 1909, **55**, II, 555, Chem. Zentr. 1909, **80**, II, 1515, Chem. Ztg. Rep. 1909, **33**, 564, Jahr. Chem. 1909, **62**, II, 390, Chem. Zts. 1910, **9**, 1862, Mon. Sci. 1913, **79**, 38.

14. O. Anselmino, Ber. Pharm. 1906, 390, Apoth. Ztg. 1906, **21**, 1050, abst. J. S. C. I. 1907, **26**, 276.

15. Badische Anilin & Soda Fabrik, E. P. 17291, 1911, 5125, 21367, 21368, 1912, abst. C. A. 1913, **7**, 399, J. S. C. I. 1913, **32**, 410. D. R. P. 211239, 1907; abst. J. S. C. I. 1909, **28**, 790, Chem. Zentr. 1909, **80**, II, 666, Chem. Tech. Rep. 1909, **33**, 422, Chem. Ind. 1909, **32**, 406, Wag. Jahr. 1909, **55**, II, 39. D. R. P. 251100, 251351, 255692, 263404, abst. C. A. 1912, **6**, 2290; Zts. ang. Chem. 1912, **25**, 2191, Kunst. 1912, **2**, 392. F. P. 456096, 1913; abst. J. S. C. I. 1913, **32**, 1120. Holl. P. 27, 1913, C. A. 1914, **8**, 2456.

16. E. Sprongerts, U. S. P. 922538, 1909, D. R. P. 204922, 1907, abst.

Schenck,¹ and W. Steinkopf and G. Kirchhoff² have described the uses and limitations of tetranitromethane. Solvent combinations have also been described by R. Stewart,³ C. Reihl and A. Waters,⁴ L. Kramer,⁵ Lengfellner,⁶ H. Keller,⁷ M. Kohn,⁸ Chemische Fabrik Griesheim,⁹ J. Dickson¹⁰ and T. Stack and W. Seck.¹¹

The period 1910-1920 contains notable additions to cellulose ester solvents. W. Plinatus has described the usefulness of glycol and glyceryl butyrates and benzoates;¹² while menthylated oil of wintergreen,¹³ ethyl lactate,¹⁴ glycidic phenolate,¹⁵ ethyl *p*-toluate,¹⁶ veratrol, safrol,¹⁷ isobutyl benzoate,¹⁸ ethers of diphenylglyceryl,

J. S. C. I. 1909, **28**, 108.

17. F. D. 384079, 1907; abst. C. A. 1909, **3**, 1690; abst. Mon. Sci. 1909, **71**, 11; C. A. 1909, **3**, 1690.

18. D. R. P. 201907, 1907; abst. J. S. C. I. 1908, **27**, 1174; Zts. ang. Chem. 1908, **21**, 2427; Chem. Zentr. 1908, **79**, II, 1398; Chem. Tech. Rep. 1908, **32**, 534; Wag. Jahr. 1908, **54**, II, 364.

1. D. R. P. 211198, 211199, 1908; abst. C. A. 1909, **3**, 2205; J. S. C. I. 1909, **28**, 815.

2. Ber. 1909, **42**, 3438; abst. J. S. C. I. 1910, **29**, 1104. See E. Berger, E. P. 127031, 1917; abst. J. S. C. I. 1919, **38**, 555-A. Compt. rend. 1910, **151**, 813; Bull. Soc. Chim. 1911, **9**, 26. Pictet and Genequand, Arch. sci. Phys. Nat. (4), **16**, 193. D. Chattaway, Proc. Chem. Soc. 1910, **26**, 164. K. Orton and P. McKie, J. C. S. 1920, **117**, 283; abst. J. S. C. I. 1920, **39**, 384-A. A. Moreschi, Atti. R. Accad. Lincei, 1919, **28**, I, 277; abst. J. S. C. I. 1919, **38**, 555-A.

3. U. S. P. 931519, 1909; abst. C. A. 1909, **3**, 2632.

4. E. P. 27092, 1906; abst. J. S. C. I. 1907, **26**, 1099; C. A. 1907, **3**, 336.

5. U. S. P. 882947, 1908; abst. Mon. Sci. 1909, **71**, 143; Chem. Ztg. Rep. 1908, **32**, 250; C. A. 1908, **2**, 2308.

6. Med. Wschr. 1907, **54**, 2039.

7. D. R. P. 220322, 1908; abst. Chem. Zentr. 1910, **81**, I, 1309.

8. D. R. P. 208635, 1907; abst. Chem. Zentr. 1909, **80**, I, 1282.

9. D. R. P. 246242, 1910; abst. C. A. 1912, **6**, 2496; Zts. ang. Chem. 1912, **25**, 1151; J. S. C. I. 1912, **31**, 605; Chem. Zentr. 1912, **83**, I, 1677.

10. U. S. P. 853685, 871790, 1907; abst. Chm. Ztg. Rep. 1907, **31**, 283; C. A. 1907, **1**, 2182, 2190.

11. U. S. P. 747898, 1903; abst. J. Soc. Dyers Color. 1904, **20**, 94.

12. E. P. 16940, 1913; F. P. 476991, 1914; abst. J. S. C. I. 1915, **34**, 703; 1916, **35**, 597.

13. G. Bleiberger, U. S. P. 979416, 1910; abst. Chem. Ztg. Rep. 1911, **35**, 195.

14. Chemische Werke vorm. Dr. H. Byke, E. P. 11741, 25182, 1913; F. P. 464617, 1913.

15. Compagnie Generale de Phonographes de Cinematographes et Appareils de Precision, Swiss P. 61929, 1912. Ital. P. 125633.

16. K. v. Auwers, Ber. 1912, **45**, 2770; abst. Chem. Zentr. 1912, **83**, II, 1819.

17. H. Dreyfus, Swiss P. 63585, 1911.

18. Darling, Proc. Phys. Soc. 1912, **24**, 223.

phenylglycid, glyceryldicresyl,¹ benzol and acetylene tetrachloride,² methylethyl *o*-phthalate, dimethyl *o*-phthalate (ävolin),³ glyceryl phthalate,⁴ menthyl methyl salicylate,⁵ trinitroanisol, trinitrophenetol,⁶ polymerized cinnamene or styrolene,⁷ benzene and alcohol,⁸ comprize bodies of solvent value, many of them being of distinct therapeutic action.⁹

In addition may be mentioned ethereal nitrates,¹⁰ monochlorhydrin,¹¹ glyceryl cinnamate and chlorethyl-, chlormethyl-, chloroxypropyl-, cinnamates,¹² tanacetyl alcohols, to which the dissolving power of oil of tansy has been ascribed¹³ in conjunction with tanacetone, ether, camphor and glycerol,¹⁴ ethyl phthalate with ethylbenzyl ether,¹⁵ methyl or ethyl chlorides,¹⁶ glyceryl acetate,¹⁷ cyclohexyl acetate,¹⁸ vetivenol acetate,¹⁹ nitrated naphtha,²⁰ pri-

1. H. Danzer, U. S. P. 1089910, 1914; abst. C. A. 1914, **8**, 1551; Mon. Sci. 1914, **81**, 106.

2. Firma Kromfag Vegyeszeti Gyar Syabo es Tarsai, Aust. P. 52207, 1911.

3. C. Kleber, U. S. P. 969636, 1910. See also A. Hesse, U. S. P. 1017669, 1912; E. P. 12633, 1910; F. P. 416806; add. May 7, 1912; D. R. P. 227667, 1906; 251237, 1910; abst. J. S. C. I. 1910, **29**, 1398; 1911, **30**, 815; 1912, **31**, 1054, 1094; C. A. 1911, **5**, 2155; 1913, **7**, 218; Zts. ang. Chem. 1910, **23**, 2348; 1912, **25**, 2239; Chem. Zentr. 1910, **81**, II, 1579.

4. General Electric Co., E. P. 3271, 1913; abst. C. A. 1914, **8**, 2628.

5. Blieberger, Weber & Co., E. P. 28378, 1910; abst. J. S. C. I. 1911, **30**, 982.

6. H. Maxim, E. P. 2039, 1910; U. S. P. 951445, 974900, 1910; abst. J. S. C. I. 1910, **29**, 518, 1412, 1476.

7. F. Matthews and E. Strange, E. P. 16277, 1911; 12770, 1912. See E. P. 17378, 1900.

8. C. Massmann, D. R. P. 250421, 1910; abst. C. A. 1912, **6**, 3518; Zts. ang. Chem. 1912, **25**, 2510; J. S. C. I. 1912, **31**, 1175; Kunst. 1913, **3**, 37; Wag. Jahr. 1912, **58**, II, 606. See H. Walker, U. S. P. 972953, 1910; Aust. P. 60087; abst. Chem. Ztg. 1913, **37**, 818.

9. A process for preparing cetyl alcohol is described by S. Axelrad and I. Hochstädter, U. S. P. 1290870, 1919; abst. J. S. C. I. 1919, **38**, 268-A.

10. J. and M. McPhie, E. P. 4214, 1913; abst. C. A. 1914, **8**, 2816; J. S. C. I. 1914, **33**, 431.

11. Sprengstoffwerke R. Nahnsen, E. P. 26036, 1911; 15093, 1913; F. P. 437315, 1911; D. R. P. 254709, 1911; abst. C. A. 1912, **6**, 2674; 1913, **7**, 807; J. S. C. I. 1912, **31**, 557, 1147.

12. F. Bayer & Co., E. P. 28247, 1910; abst. J. S. C. I. 1911, **30**, 1333; J. Soc. Dyers Color. 1911, **27**, 311; C. A. 1912, **6**, 1500.

13. V. Paolini, Gaz. chim. ital. 1912, **42**, I, 41; abst. J. S. C. I. 1912, **31**, 300.

14. P. Pierson, E. P. 26787, 26788, 1913; 9973, 1914; F. P. 465506, 1913; abst. C. A. 1914, **8**, 3538; 1915, **9**, 1282, 2801.

15. F. Nathan, W. Rintoul and F. Baker, E. P. 4940, 1913. In this connection see E. P. 14231, 1900; 12742, 12743, 12745, 12746, 1912.

16. A. Rousseau, F. P. 465586, 1913; abst. C. A. 1914, **8**, 3387.

17. M. Salamon and W. Seaber, Perf. Essent. Oil Record, **3**, 275;

mary olefine oxides,¹ and nitrated castor oil.² Acetated castor oil is not a solvent of acetylcellulose.

In a patent issued to L. Lilienfeld is specified pyridine, quinoline, picoline, ethyl esters of phthalic, sebacic, citric, succinic, tartaric, benzoic, levulinic acids, and phenyl ether among a host of others.³ Safrol,⁴ mononitro benzenoid hydrocarbons,⁵ the methyl, ethyl, propyl, butyl and amyl acetates, propionates, butyrates, valerates, and caproates,⁶ *p*-nitrotoluene, chloronitrobenzene,⁷ glyceryl methyl ether dinitrate (*α*-methylin dinitrate),⁸ tetrachlorethane with Venice turpentine,⁹ and cephalin ethyl, propyl, butyl, isoamyl and cephalin allyl ethers.¹⁰ To this category may be added furfural,¹¹ and acetol,¹² as well as the solvent combinations described by D. Reid,¹³ A. Hoffmann,¹⁴ M. Hitt,¹⁵ F.

abst. C. A. 1913, **7**, 863.

18. J. Senderens and J. Aboulene, *Compt. rend.* 1912, **155**, 1013.

19. F. Semmler, F. Risse and F. Schroter, *Ber.* 1912, **45**, 2348.

20. O. Silberrad, U. S. P. 1092758; 1914, E. P. 13861, 1911; 512, 799, 1912; abst. J. S. C. I. 1912, **31**, 978, 1914, **33**, 504; C. A. 1913, **7**, 258, 2301

1. H. Walker, U. S. P. 972952, 972953, 972954, 1910, E. P. 22309, 1910, F. P. 421058, 1910; D. R. P. 267205, 1910, Aust. P. 6008; abst. J. S. C. I. 1910, **29**, 1299, 1305, 1332; 1911, **30**, 416, 533, C. A. 1911, **5**, 150; 1914, **8**, 1853; *Kunst.* 1911, **1**, 316; 1913, **3**, 50; 1914, **4**, 236, *Wag. Jahr.* 1912, **58**, II, 15.

2. R. Brightman, J. S. C. I. 1917, **36**, 984, abst. C. A. 1918, **12**, 98. See also The Velvrl Co., Ltd., F. P. 341407, 1901; E. P. 13306, 1903; abst. J. S. C. I. 1904, **23**, 670.

3. F. P. 459972, 1913; abst. C. A. 1914, **8**, 3373, *Chem. Ztg. Rep.* 1914, **38**, 394.

4. Z. Umitakara, *Jap. P.* 29893, 1916, abst. C. A. 1917, **11**, 525.

5. E. Barnes, U. S. P. 1273568, 1918, abst. J. S. C. I. 1918, **37**, 638-A.

6. Societe D'Etude du Carburol, F. P. 461520, 1913. C. Fiske (*J. Biol. Chem.* 1918, **35**, 411; abst. J. S. C. I. 1918, **37**, 606-A) covers isoamyl isovalerate. Cellon Ltd., T. Tyrer & Co. and T. Tucker (*E. P.* 123628, 1918; abst. C. A. 1919, **13**, 1646) covers the use of isobutyl isobutyrate. Methyl acetate and acetone produced by the action of fatty acids on alcohols in the presence of carbides have been described by A. Kanamori, *Jap. P.* 34855; abst. C. A. 1920, **14**, 1219.

7. E. van den Kerkoff, F. P. 429879, 1911.

8. D. Jones, J. C. S. 1919, **115**, 76; abst. J. S. C. I. 1919, **38**, 119-A.

9. J. Matray, F. P. 477294, 1915; abst. J. S. C. I. 1916, **35**, 597.

10. J. Meader, U. S. P. 1219571, 1219572, 1219573, 1219574, 1219575, 1917; abst. C. A. 1917, **11**, 1758.

11. F. Meunier, F. P. 472423, 1913; abst. J. S. C. I. 1915, **34**, 500. The use of furfural has been patented by G. Bonwitt, E. P. 138078, 1919; abst. *Chem. Met. Eng.* 1920, **23**, 35. See also *Chem. Fabrik. von Heyden A-G.*, D. R. P. 302460; abst. J. S. C. I. 1920, **39**, 430-A.

12. Baudisch, *Biochem. Zts.* 1918, **89**, 279; abst. J. S. C. I. 1918, **37**, 672-A.

13. U. S. P. 1095999, 1914; abst. C. A. 1914, **8**, 2124; *Mon. Sci.* 1914, **81**, 146. Cf. S. Schwimmer, *Hung. P. Appl. Sch.* 2847, 1913; abst. *Chem. Ztg.* 1913, **37**, 1433.

14. D. R. P. 229678; abst. *Wag. Jahr.* 1911, **57**, II, 12; *Chem. Zentr.*

Kniffen,¹ Debaugé & Co.,² R. Ellison,³ W. Dunville & Co. and R. Gilmour,⁴ B. Szanyi⁵ and Schleu.⁶ General résumé of the subject have been published by F. Zimmer,⁷ H. Schwarz⁸ and A. Conley.⁹

Undoubtedly many of the above named solvents, high boilers and plastifying agents, only await more economical methods of manufacture to permit of their use in this art in comparatively large quantities.

Acetone and the Ketones. Acetone is one of the most valuable cellulose ester solvents, especially in connection with smokeless powder and cellulose acetate manufacture. Acetone may be manufactured by (1) dry distillation of calcium acetate, as in the processes of F. Frerichs,¹⁰ C. Lowe,¹¹ A. Bauschlicher,¹² J. Squibb,¹³ H. Chute,¹⁴ Rheinische Holzdestillation Ges.,¹⁵ A. Pages and R. Duchemin,¹⁶ C. de la Gabinie and E. Diligeon¹⁷ with P. la Freynay,¹⁸ J. Jedlika,¹⁹ C. Kietabl,²⁰ J. Senderens,²¹ L. Wenghofer,²² 1911, **82**, I, 275

- 15 U. S. P. 1321633, 1321634, 1919, abst. C. A. 1920, **14**, 223
1. U. S. P. 1118498, 1914, abst. C. A. 1915, **9**, 153.
- 2 F. P. 418347, 1910
- 3 U. S. P. 1104744, 1914, abst. C. A. 1914, **8**, 3127, Zts. ang. Chem. 1915, **28**, I, 351.
4. E. P. 131647, 132096, 1918, abst. J. S. C. I. 1919, **38**, 896-A, 915-A.
5. D. R. P. 234264, Aust. P. 53482, abst. Chem. Zentr. 1911, **82**, I, 1662
6. E. P. Appl. 23036, 1911; abst. J. S. C. I. 1911, **30**, 1288.
7. Farben. Ztg. 1919, **24**, 841, abst. C. A. 1919, **13**, 2607
8. Zts. anal. Chem. 1884, **23**, 368, abst. J. S. C. I. 1884, **3**, 648. Kunst. 1913, **3**, 341, 370. Caoutch. Gutta 1914, 3859, abst. C. A. 1915, **9**, 152.
9. J. Ind. Eng. Chem. 1915, **7**, 882, abst. C. A. 1916, **10**, 969, Chem. Zentr. 1915, **86**, II, 1314.
- 10 U. S. P. 430734, 1890, abst. J. A. C. S. 1890, **12**, 242.
11. E. P. 12660, 1892; abst. Mon. Sci. 1893, **42**, 142, 1894, **44**, 20; Chem. Centr. 1893, **64**, I, 190, J. S. C. I. 1892, **11**, 798
12. U. S. P. 608019, 1898.
13. J. A. C. S. 1895, **17**, 187. Cf. J. A. C. S. 1896, **18**, 1068; abst. J. C. S. 1897, **72**, ii, 466.
14. U. S. P. 648389, 1900; abst. Mon. Sci. 1900, **56**, 191
15. Belg. P. 182432, 1905. See L. Rappaport, E. P. 137558, 1918; abst. C. A. 1920, **14**, 1341.
16. U. S. P. 933107, 1907; E. P. 8757, 1906, 13508, 1907, F. P. 361379, 1905; add. July 27, 1906; abst. J. S. C. I. 1906, **25**, 634, 1907, **26**, 43, 958; 1909, **28**, 1029.
17. F. P. 439732, 1911; abst. J. S. C. I. 1912, **31**, 741. Mon. Sci. 1913, **79**, 137; Chem. Ztg. 1912, **36**, 618.
18. F. P. 451374, 1912; abst. J. S. C. I. 1913, **32**, 625, C. A. 1913, **7**, 3227; Chem. Ztg. 1913, **37**, 336.
19. Chemicke Lesty, **5**, 135; abst. C. A. 1911, **5**, 2078.
20. Aust. P. 43636, 1910. C. Jacobs, U. S. P. 719223, 1903, for manu-

and J. Becker,¹ or (2) by the distillation of sawdust or the waste liquor from sulfite pulp manufacture as in the methods of C. Beadle and H. Stevens,² H. Bassett,³ J. Hawliczek,⁴ V. Drewsen,⁵ E. Rinman,⁶ N. Statham,⁷ A. White and J. Rue,⁸ J. Effront,⁹ N. Sidgwick and B. Lambert,¹⁰ and the Soc. Chimiques des usines du Rhone,¹¹ or (3) from acetic acid, as in the processes of F. Hurter,¹² Pages, Camus & Co.,¹³ G. Curme,¹⁴ M. Darrin,¹⁵ H. Merton,¹⁶ and K. Elbs and K. Brand.¹⁷

Recently a series of fermentative and bacteriological processes for acetone formation have been described, which bid fair for the manufacture of acetone and cyanides.

21. J. Senderens, *Compt. rend.* 1912, **154**, 1518; abst. C. A. 1912, **31**, 660.
22. F. P. 320519; abst. *Mon. Sci.* 1903, **59**, 124; *Chem. Ztg.* 1903, **27**, 58; *Chem. Zts.* 1903, **2**, 675.
 1. D. R. P. 170533, 1903; abst. J. S. C. I. 1907, **26**, 279; *Wag. Jahr.* 1906, **52**, II, 19. For losses in the preparation of acetone by acetate of lime distillation, see L. Goodwin and E. Sterne, *J. Ind. Eng. Chem.* 1920, **12**, 240; abst. J. S. C. I. 1920, **39**, 396-A.
 2. *World's Paper Trade Review*, 1909, **51**, 945.
 3. *Chem. Met. Eng.* 1919, **20**, 190; abst. C. A. 1919, **13**, 1015; J. S. C. I. 1919, **38**, 246-A.
 4. U. S. P. 690724, 1902; E. P. 1898, 1907; Belg. P. 143386, 1899; abst. J. S. C. I. 1899, **18**, 824; 1902, **21**, 246.
 5. U. S. P. 1298479, 1919; abst. C. A. 1919, **13**, 1764.
 6. U. S. P. 1202317, 1916; abst. C. A. 1917, **11**, 99.
 7. U. S. P. 1298594, 1919; abst. C. A. 1919, **13**, 1715.
 8. *Met. Chem. Eng.* 1917, **16**, 182; abst. C. A. 1917, **11**, 2405. See *Paper*, 1917, **19**, No. 23, 56; abst. C. A. 1917, **11**, 1544. A. White, U. S. P. 1197983, 1916; abst. C. A. 1916, **10**, 3160.
 9. U. S. P. 1048814, 1912; E. P. 2867, 1912; F. P. 439683, 1912; Belg. P. 240315, 1911; abst. J. S. C. I. 1912, **31**, 711; 1913, **32**, 161.
 10. E. P. 14085, 1915; abst. J. S. C. I. 1919, **38**, 304-A.
 11. E. P. 126279, 1919; abst. C. A. 1919, **13**, 2156. Refer to Soc. Anon. des Acieries and Forges de Firminy, E. P. 134144, 1919; abst. J. S. C. I. 1920, **39**, 44-A; C. A. 1920, **14**, 746.
 12. E. P. 2816, 1898; abst. *Chem. Ztg.* 1899, **23**, 501.
 13. E. P. 8757, 1906; 13508, 1907; F. P. 361379, 1905; First add. 6531, 1906; 2nd add. March 8, 1907; 3rd add. Oct. 10, 1907; abst. J. S. C. I. 1906, **25**, 634, 687; 1907, **26**, 43, 958, 1002; 1908, **27**, 277; C. A. 1907, **1**, 2322. Belg. P. 191133, 1906; 200530, 1907; Aust. P. 33667, 33668, 1908; 37553, 1909; D. R. P. 198852, 214151, 214152.
 14. U. S. P. 1315544, 1919; abst. C. A. 1919, **13**, 2882; J. S. C. I. 1919, **38**, 847-A.
 15. *J. Ind. Eng. Chem.* 1915, **7**, 927; abst. J. S. C. I. 1915, **34**, 1201. For description of synthetic acetone and acetic acid processes from calcium carbide of Shawinigan Water & Power Co., see J. Rooney, *Chem. Met. Eng.* 1920, **22**, 847; abst. C. A. 1920, **14**, 1971.
 16. U. S. P. 1215525, 1919; abst. C. A. 1919, **13**, 2882; J. S. C. I. 1919, **38**, 847-A. H. Matheson, E. P. 137388, 138679, 1919; abst. J. S. C. I. 1920, **39**, 312-A; C. A. 1920, **14**, 1341, 1835.
 17. *Zts. Elektro. Chem.* 1901-1902, **8**, 783; abst. J. S. C. I. 1902, **21**, 1334. For methyl-ethyl ketone from *n*-butyl alcohol, see T. Newman, *Can. Chem. J.* 1920, **4**, 47; abst. C. A. 1920, **14**, 1120.

to entirely change the economical aspects of the production of this solvent. This advancement has been based on the discoveries of C. Weizmann,¹ H. Speakman,² E. Ricard,³ J. Northrup, L. Ashe and J. Senior,⁴ G. Mezzadrolì,⁵ A. Fernbach,⁶ A. Desborough, J. Reilly and A. Thaysen,⁷ K. Delbrück,⁸ A. Petrillo,⁹ F. Bayer & Co.,¹⁰ G. Periere and G. Guignard,¹¹ A. Gill,¹² and F. Nathan.¹³ The bacteriological processes give roughly 2 parts of *n*-butyl alcohol per part of acetone produced, although it appears conditions may be so varied that much larger proportions of butyl alcohol result. It has been proposed to change this butyl alcohol into methyl-ethyl ketone (MEK). H. Dakin¹⁴ heats ammonium salts of fatty acids with excess of 3% H₂O₂ solution, obtaining ethyl-methyl, propyl-methyl, amyl-methyl, and heptyl-methyl ketones, respectively, from *n*-valeric, *n*-caproic, caprylic, nonylic and capric acids. Kelp¹⁵ and seaweed¹⁶ are also interesting sources

1. U. S. P. 1315585, 1919; E. P. 4845, 1915; abst. C. A. 1919, **13**, 1595, 2882; J. S. C. I. 1919, **38**, 301-A, 840-A. C. Weizman and G. Hamlyn, U. S. P. 1329214, 1920; abst. J. S. C. I. 1920, **39**, 276-A. C. Weizman, Can. P. 195279. In this connection see J. Reilly, W. Hickenbottom, F. Henley and A. Thaysen, Biochem. J. 1920, **14**, No. 2.
2. J. S. C. I. 1919, **38**, 155-T; abst. C. A. 1919, **13**, 2198. F. P. 439683, 1912. Hung. Appl. E-1897, 1912. J. Biol. Chem. 1920, **41**, 219; abst. J. S. C. I. 1920, **39**, 381-A.
3. E. P. 130666, 1918; abst. J. S. C. I. 1919, **38**, 787-A.
4. J. Biol. Chem. 1919, **39**, 1; abst. J. S. C. I. 1919, **38**, 734-A. J. Northrup, U. S. P. 1293172, 1919; abst. J. S. C. I. 1919, **38**, 334-A; C. A. 1919, **13**, 1075. J. Northrup, L. Ashe and R. Morgan, J. Ind. Eng. Chem. 1919, **11**, 723; abst. J. S. C. I. 1919, **38**, 786. See also J. S. C. I. 1919, **38**, 271-T.
5. Boll. Assoc. Ind. Zucch. Alcool, Bologna, 1917, **9**, 142; Bull. Agric. Intell. 1917, **8**, 787; J. S. C. I. 1917, **36**, 1024.
6. E. P. 109969, 1917; abst. C. A. 1918, **12**, 155. A. Fernbach and E. Strange, E. P. 15561, 1898; 15203, 15204, 16925, 1911; 21073, 1912; 14607, 1915; F. P. 448364, 1912; abst. J. S. C. I. 1912, **31**, 1091, 1143; 1913, **32**, 377, 987; 1919, **38**, 333-A; C. A. 1913, **7**, 396. Belg. P. 249254, 1912. D. R. P. Anm. F. 3519. Hung. Anm. F-3082; abst. Chem. Ztg. 1913, **37**, 163. Australia P. 10274, 1913. D. R. P. 323533, 1912.
7. E. P. 128403, 128714, 1918; abst. C. A. 1919, **13**, 2882, 2883; J. S. C. I. 1919, **38**, 486-A, 693-A.
8. U. S. P. 1169322, 1916; abst. C. A. 1916, **10**, 953.
9. Ital. P. 141268, 1914; abst. C. A. 1915, **9**, 2797.
10. E. P. 14371, 1914; abst. J. S. C. I. 1915, **34**, 976.
11. F. P. 316060, 316061, 1901; abst. J. S. C. I. 1902, **21**, 541, 1096.
12. J. S. C. I. 1919, **38**, 273-T; abst. Chem. Trade J. 1919, **65**, 113; C. A. 1919, **13**, 2678. For production of acetone and *n*-butyl alcohol by fermentation of horse chestnuts, see A. Gill, J. S. C. I. 1919, **38**, 411; abst. C. A. 1920, **14**, 793.
13. J. S. C. I. 1919, **38**, 271; abst. Chem. Trade J. 1919, **65**, 113; C. A. 1919, **13**, 2678.
14. Amer. Chem. J. 1910, **44**, 41; abst. J. S. C. I. 1910, **29**, 962.
15. C. Higgins, J. Ind. Eng. Chem. 1918, **10**, 858; C. A. 1918, **12**, 2666.
16. J. Hendrick, J. S. C. I. 1916, **35**, 565.

of acetone. This ketone is usually¹ purified by rectification,¹ as detailed by K. Joh,² K. Shipsey and E. Werner,³ L. Hawley,⁴ K. Freudenberg,⁵ and J. Arnoult and I. Jumauf.⁶

The density of acetone, according to Dutilh,⁷ A. Dunstan and T. Hilditch,⁸ F. Eisenlohr,⁹ J. Hubbard,¹⁰ F. Körber,¹¹ H. Malosse,¹² F. Schwers,¹³ O. Stern,¹⁴ T. Timmermans,¹⁵ H. Kopp,¹⁶ E. Linnemann,¹⁷ D. Mendelejeff,¹⁸ M. Grodzki and G. Krämer,¹⁹ T. Thorpe,²⁰ J. Brühl,²¹ A. Zander,²² H. Schiff,²³ W. Perkin,²⁴ is

1. O. Porsch, U. S. P. 535552, 535553, 1895; E. P. 5255, 1895.
2. D. R. P. Ann. F. 37296, 1013; abst. Kunst. 1914, **4**, 280.
3. Proc. Chem. Soc. 1913, **29**, 194; J. C. S. 1913, **103**, 1255; C. A. 1913, **7**, 3317; J. S. C. I. 1913, **32**, 611.
4. U. S. P. 1106707, 1914; abst. C. A. 1914, **8**, 3362; J. S. C. I. 1914, **33**, 954.
5. D. R. P. 281473, 1913; abst. Kunst. 1914, **4**, 396, 1915, **5**, 81; J. S. C. I. 1915, **34**, 735. See also E. Fischer and K. Hoesch, Ann. 1912, **391**, 348.
6. F. P. 386181, 1907; abst. J. S. C. I. 1908, **27**, 679.
7. Verh. K. Akad. Wet. Amst. **11**, 44.
8. Zts. Electrochem. 1912, **18**, 186.
9. Zts. physik. Chem. 1910, **75**, 585; abst. Bull. Soc. Chim. 1911, **10**, 1221; Chem. Zentr. 1911, **82**, I, 625; J. C. S. 1911, **100**, ii, 81; C. A. 1911, **5**, 1218.
10. Zts. physik. Chem. 1910, **74**, 217; abst. Bull. Soc. Chim. 1911, **10**, 831; J. C. S. 1910, **98**, ii, 800; C. A. 1910, **4**, 2401.
11. Ann. Physik. **37**, 1021.
12. Compt. rend. 1912, **154**, 1697; abst. C. A. 1912, **6**, 2351.
13. J. chim. phys. 1911, **9**, 16. See also Zts. physik. Chem. 1910, **75**, 615, 621.
14. Zts. physik. Chem. 1912, **81**, 441; abst. C. A. 1913, **7**, 274.
15. Bull. Soc. Chim. Belg. **26**, 207; Proc. Roy. Dub. Soc. **13**, 326.
16. Pogg. Ann. 1847, **72**, 239; abst. Jahr. Chem. 1847-1848, **1**, 65.
17. Ann. 1867, **143**, 349; abst. Jahr. Chem. 1867, **20**, 562; J. prakt. Chem. 1868, **103**, 186; Zts. Chem. 1868, **57**, Chem. Centr. 1868, **39**, 350; Ann. Chim. Phys. 1868, (4), **13**, 499; Bull. Soc. Chim. 1868, **9**, 477.
18. Compt. rend. 1860, **50**, 42; Zts. Chem. Pharm. 1860, **49**, Chem. Centr. 1860, **31**, 177; Ausz. Rep. chim. Pure, **2**, 109; Jahr. Chem. 1860, **13**, 7.
19. Zts. anal. Chem. 1875, **14**, 103. See Ber. 1874, **7**, 1492; Chem. Centr. 1875, **46**, 3; J. C. S. 1875, **28**, 117.
20. J. C. S. 1880, **37**, 371, abst. Chem. News, 1880, **41**, 120, Jahr. Chem. 1880, **33**, 18.
21. Ber. 1880, **13**, 1527; Ann. 1880, **203**, 255, 363; abst. Jahr. Chem. 1880, **33**, 6.
22. Ann. 1882, **214**, 181; abst. Jahr. Chem. 1882, **35**, 27; 1883, **36**, 72.
23. Gazz. chim. ital. 1883, **13**, 177. See Ann. 1883, **218**, 185; abst. Jahr. Chem. 1883, **36**, 1134.
24. J. prakt. Chem. 1885, **139**, 481; **140**, 523. E. P. 24067, 1906; abst. J. S. C. I. 1907, **26**, 1213. F. P. 371447, 1906; abst. J. S. C. I. 1907, **26**, 340; Mon. Sci. 1908, **63**, 79; Chem. Tech. Rep. 1907, **31**, 149. U. S. P. 838350, 1906; abst. J. S. C. I. 1907, **26**, 165; Mon. Sci. 1907, **66**, 1161. Revisue 12637 thereon dated April 23, 1907; abst. J. S. C. I. 1907, **26**, 634; Mon. Sci. 1907, **66**, 159. E. P. 19330, 1905, Void; abst. J. S. C. I. 1906, **25**, 865. F. P. 358079, 1905; abst. Mon. Sci. 1906, **64**, 169; J. S. C. I. 1906, **25**, 195. Hung. P. 35866, 1905. Belg. P. 187308, 1905. Aust. P. 41461, 1909. Can. P. 103045. It. P. No. 97, Vol. 215, 1905. D. R. P. Ann. M. 28289, 1905.

0.785 at 25°/4°, 0.797 at 20°/4°. Vapor pressures and densities for the system acetone-methyl-ethyl ketone have been determined by T. Price,¹ and for butyl alcohol-acetone-water by J. Reilly and E. Ralph,² for acetone-ether by J. Sameshima,³ and for acetone-chloroform by A. Schulze.⁴ Acetone and silicon tetrachloride give mesityl oxide.⁵

Sunlight interferes with the permanganate test for purity in acetone.⁶

In addition to its wide use as a solvent of both nitrocellulose

F. P. 427265, 1911, abst. J. S. C. I. 1911, **30**, 1051. Chem. Tech. Rep. 1911, **35**, 481. Hung. Appl. O-674, 1912. Aust. P. 29b. A. 1787, 1912; abst. Kunst. 1912, **2**, 460. U. S. P. 734123, 1903; abst. J. S. C. I. 1903, **22**, 964. Mon. Sci. 1903, **60**, 173. U. S. P. 790565, 1905; abst. J. S. C. I. 1905, **24**, 686. D. R. P. 153350, 1901; abst. Zts. ang. Chem. 1904, **17**, 1697; Chem. Centr. 1904, **75**, II, 625; Jahr. Chem. 1904, **57**, 1168, J. C. S. 1904, **86**, i, 853; Chem. Ind. 1904, **27**, 538. D. R. P. 159524, 1901, abst. Chem. Centr. 1905, **76**, II, 527; Zts. ang. Chem. 1905, **18**, 1636, Jahr. Chem. 1905-1908, **18**, 984, J. C. S. 1906, **90**, i, 6; Chem. Ind. 1905, **28**, 535. E. P. 21638, 1901; abst. J. S. C. I. 1902, **21**, 870. F. P. 317007, 1901, abst. J. S. C. I. 1902, **21**, 870, Mon. Sci. 1903, **60**, 54. Aust. P. 31391. It. P. 62042, 1901. U. S. P. 987692, 1911; abst. J. S. C. I. 1911, **30**, 485, Chem. Tech. Rep. 1911, **35**, 250. E. P. 14271, 1910, abst. J. S. C. I. 1911, **30**, 485. F. P. 417274, 1910; abst. J. S. C. I. 1911, **30**, 485. Aust. P. of Aug. 14, 1909; July 21, 1910. D. R. P. 222450, 1908, abst. J. S. C. I. 1910, **29**, 811; Zts. ang. Chem. 1910, **23**, 1389; Wag. Jahr. 1910, **56**, II, 434; Chem. Zentr. 1910, **81**, 48; Chem. Zts. 1910, **9**, 1902; C. A. 1910, **4**, 2875. E. P. 4863, 1903, abst. J. S. C. I. 1904, **23**, 382. F. P. 324121, 1902; abst. J. S. C. I. 1904, **23**, 569. F. P. 432046, 1911; abst. J. S. C. I. 1912, **31**, 24. First Add. dated July 7, 1911, to F. P. 432046; abst. J. S. C. I. 1912, **31**, 225. Second Add. to F. P. 432046, abst. J. S. C. I. 1912, **31**, 225. Third Add. 15933, dated Jan. 4, 1912, to F. P. 432046; abst. Chem. Ztg. 1912, **34**, 1174. Fourth Add. 15894, dated April 4, 1912; abst. J. S. C. I. 1912, **31**, 1119. Fifth Add. 16316, dated April 1, 1912; abst. J. S. C. I. 1912, **31**, 1119. Sixth Add. dated Aug. 5, 1912, to F. P. 432046; abst. J. S. C. I. 1913, **32**, 289. Seventh Add. dated Sept. 16, 1912, to F. P. 432046; abst. J. S. C. I. 1913, **32**, 420. E. P. 20978, 1911, same as First Add. to F. P. 432046, abst. Kunst. 1913, **3**, 195. E. P. 20852, 1912. E. P. 21376, 1912, division of 20978, 1911, abst. J. S. C. I. 1913, **32**, 133. E. P. 20977, 1911, same as F. Appl. July 5, 1911; abst. J. S. C. I. 1913, **32**, 133; C. A. 1913, **7**, 891. Belg. P. 241250, 246250, 246251, 1912. Aust. P. Ann. 120, Mar. 16, 1910, Mar. 9, 1911.

1. J. C. S. 1919, **115**, 1116, abst. J. S. C. I. 1919, **38**, 845-A. For the vapor pressure of acetone, see G. Parajpe, J. Ind. Inst. Sci. 1918, **2**, 47; abst. J. C. S. 1920, **118**, i, 369. J. Reilly, W. Hickinbottom, F. Henley and A. Thaysen, Biochem. J. 1920, **14**, 229; abst. J. S. C. I. 1920, **39**, 421-A; C. A. 1920, **14**, 2048.

2. Sci. Proc. Roy. Dub. Soc. 1919, **15**, 597; abst. C. A. 1919, **13**, 1970. For acetone from calcium carbide, see Union Carbide Co., Can. P. 194062, 1919. G. Dalen, Ital. P. 126123; abst. Chem. Ztg. 1913, **37**, 284. Swed. P. 34285; abst. Chem. Ztg. 1913, **37**, 567.

3. J. A. C. S. 1918, **40**, 1482; abst. C. A. 1918, **12**, 2470.

4. Zts. physik. Chem. 1919, **93**, 368; abst. C. A. 1919, **13**, 2476.

5. J. Currie, J. A. C. S. 1913, **35**, 1061; J. C. S. 1913, **104**, i, 1043.

6. Batik, Chem. Ztg. 1910, **34**, 735; abst. J. S. C. I. 1910, **29**, 871.

and cellulose acetate, acetone has been employed as a resin¹ and varnish solvent,² in Sprengal explosives,³ artificially seasoning wood,⁴ treating leather,⁵ manufacturing chloroform,⁶ and as a substitute for alkalis in developers.⁷ F. Bayer & Co.⁸ and the Societa "Bogatir"⁹ manufacture pinacone from acetone by means of organo-magnesium compounds. C. Piest¹⁰ and G. Noyer¹¹ have described acetone substitutes. The plastic of F. Rampichini¹² comprises celluloid and acetone.

After the distillation of acetone, there appears a higher fraction consisting of ethyl-methyl and other ketones, the distillate collectively being known as acetone oil. F. Reinglass¹³ deodorizes the oil by treatment with HCl. Acetone oil from wool washings¹⁴ has also been described as a profitable source. In the manufacture of artificial¹⁵ and pure¹⁶ rubber goods, transparent nitrocellu-

- * 1. E. Pontifex, E. P. 2033, 1864. For acetone as solvent for copal and other resins, consult Wiederhold, Neue Gewerbebl. f. Kurhessen, 1864, No. 23; abst. Poly. Centr. 1864, **30**, 1245. As solvent for Rhus vernicifera, see M. Wagner, D. R. P. 142514; abst. Wag. Jahr. 1903, **49**, II, 563.
2. Wiederhold, Dingl. Poly. 1864, **172**, 460; Bull. Soc. Chim. 1864, **2**, 476; Neue Gewerbebl. f. Kurhessen, 1864, No. 23; Poly. Centr. 1864, **30**, 1245; Poly. Notiz. 1864, **19**, 214; Gewerbebl. Hessen, 1864, 460, Jahr. Pharm. **22**, 88; Wag. Jahr. 1864, **10**, 603. The C. Lewis composition for removing carbon contains 50% acetone. The grease remover of R. Percy (Can. P. 186251) consists of acetone, acetic acid, ammonia and gasoline.
3. T. Hawkins, E. P. 17307, 1913; abst. J. S. C. I. 1914, **33**, 569. D. Westerfield and E. Rogers (Can. P. 185354, 1918) protects metals from corrosion by a coating of shellac in acetone.
4. M. Kleinstück, U. S. P. 1210491, 1917; abst. C. A. 1917, **11**, 697.
5. Anhydrot Leder Werke, Holl. P. 2430, 1918; abst. C. A. 1918, **12**, 2709. Cf. Swed. P. 41794, 1917; abst. C. A. 1917, **11**, 1765.
6. C. Rumpf, U. S. P. 383992, 385777, 393079, 1888; abst. Mon. Sci. 1889, **34**, 1365.
7. A. Lumiere and A. Seyewetz, Mon. Sci. 1903, **59**, 257; abst. J. S. C. I. 1903, **22**, 510.
8. E. P. 411, 22795, 1911; 14371, 1914; abst. C. A. 1915, **9**, 3326. D. R. P. 286148, 287933, 289497, 294683, 1914; abst. C. A. 1916, **10**, 1407, 2615; J. S. C. I. 1917, **36**, 1189. Kunst. 1914, **4**, 384. Anon., India Rubber World, 1916, **54**, 559; abst. C. A. 1916, **10**, 2541.
9. Ital. P. 135560, 1913; abst. C. A. 1915, **9**, 2797.
10. Chem. Ztg. 1913, **37**, 299; abst. C. A. 1913, **7**, 2116.
11. Caout. et Guttap. 1916, **13**, 8805; abst. J. S. C. I. 1916, **35**, 429.
12. D. R. P. 253984, 1911; abst. Chem. Ztg. 1913, **34**, I, 88; Zts. ang. Chem. 1913, **26**, 174.
13. D. R. P. 119880; abst. Wag. Jahr. 1901, **47**, II, 8; Zts. ang. Chem. 1901, **14**, 579; Chem. Centr. 1901, **72**, I, 1026.
14. P. Baechlin, Rev. Chim. Ind. **15**, 240; abst. J. S. C. I. 1903, **21**, 1271. A. and P. Buisine, Bull. Assoc. Sucr. Dist. 1901, **19**, 662; abst. J. S. C. I. 1902, **21**, 164. Cf. J. S. C. I. 1898, **17**, 266, 485; 1899, **18**, 292.
15. W. Elmer and O. Meyer, E. P. 9588, 1910; abst. J. S. C. I. 1910, **29**, 1121.
16. P. Germain, F. P. 355016, 1905; abst. C. A. 1907, **1**, 1078; Mon. Sci. 1906, **65**, 169; 1907, **67**, 598.

lose films,¹ pyroxylin lacquers,² the acetone oils have been used to a limited extent. A. Kronstein³ and H. Hibbert⁴ have also advocated new uses. Detailed examination of the acetone oils has been published by W. Jones.⁵

Ketones higher than acetone, as propione, butyrone, valerone, caprone, methyl-ethyl, methyl-propyl, methyl-butyl, methyl-valeryl, ethyl-butyl and methyl-amyl ketones have been patented⁶ as nitrocellulose solvents. Their solvent action decreases with increased molecular weight. The mixed solvent of H. Hibbert⁷ contains a large proportion of butyrone, that of J. Adler,⁸ of methyl acetone. Methods for the preparation of methyl-isopropyl⁹ and isobutyl tolyl ketones,¹⁰ have been described. A. Lassieur prepares isobutyl ketone from acetone and nickel.¹¹ Methyl-*n*-amyl ketone appears in clove oil, which dissolves the cellulose nitrates.¹² Acetone oil is an excellent wood preservative.¹³

Diacetone alcohol (4-hydroxy-2-keto-4-methylpentan) is an excellent solvent of a wide range of cellulose nitrates and acetates. The earlier researches on this body by L. Bouveault and R. Locquin,¹⁴ F. Feist and H. Belart,¹⁵ R. Fittig,¹⁶ A. Franke,¹⁷ A. Franke and M. Kohn,¹⁸ W. Heintz,¹⁹ K. Koelichen,²⁰ M. Kohn,²¹

1. G. de Briailles, Swiss P. 42338, 1908.
2. F. Crane, E. P. 6542, 6543, 1892; abst. J. S. C. I. 1893, **12**, 364, 374.
3. U. S. P. 833063, 1906; E. P. 1386, 1901, abst. J. S. C. I. 1901, **20**, 485, 1906, **25**, 1057.
4. Can. P. 171961, 1916; abst. C. A. 1918, **12**, 588.
5. J. S. C. I. 1919, **38**, 108-T; abst. C. A. 1919, **13**, 1687.
6. A. Scher, U. S. P. 470451, 1892, abst. J. A. C. S. 1892, **14**, 73.
7. U. S. P. 1283183, 1919, abst. C. A. 1919, **13**, 187. Cf. E. P. 5408, 1914; abst. C. A. 1915, **9**, 2291. For production of methyl-ethyl ketone from *n*-butyl alcohol, refer to A. King, J. C. S. 1919, **115**, 1404, abst. J. S. C. I. 1920, **39**, 134-A; C. A. 1920, **14**, 1521.
8. U. S. P. 1147066, 1915; abst. C. A. 1915, **9**, 2460.
9. Badische Anilin & Soda Fabrik, E. P. 10826, 1911, abst. C. A. 1912, **6**, 3026; J. S. C. I. 1912, **31**, 605.
10. E. Mallmann, E. P. 4018, 1894; abst. J. S. C. I. 1894, **13**, 570.
11. A. Lassieur, Compt. rend. 1913, **156**, 795; abst. J. S. C. I. 1913, **32**, 379.
12. Schimmel's Report, April 24, 1902; abst. J. S. C. I. 1902, **21**, 791.
13. Höntsch & Co., D. R. P. 237150, 239697, 1910, abst. C. A. 1912, **6**, 1977, 2160; Zts. ang. Chem. 1911, **24**, 2288.
14. Ann. Chim. Phys. 1910, (8), **21**, 407; abst. Chem. Zentr. 1911, **82**, I, 126.
15. Ber. 1895, **28**, 1817; abst. Chem. Centr. 1895, **66**, 11, 479.
16. Ann. 1859, **110**, 34; abst. Jahr. Chem. 1859, **12**, 342. See also Jahr. Chem. 1859, **12**, 347.
17. Wien. Akad. Ber. **110**, IIb, 906; abst. Jahr. Chem. 1901, **54**, 630.
18. Ber. 1904, **37**, 470; abst. Chem. Centr. 1905, **76**, I, 347. Monatsh.

M. Kohn and F. Bum,¹ F. Kuster and E. Heberlein,² M. Kohn and G. Lindauer,³ J. Lemaire,⁴ A. Lipp,⁵ A. Lipp and E. Scheller,⁶ W. Wislicenus,⁷ N. Zelinsky and J. Zelikow,⁸ have led to practical methods of commercial manufacture by J. Hertkorn,⁹ A. Hoffmann,¹⁰ C. Crockett¹¹ and W. Doerflinger.¹²

Methyl Alcohol. In general, methyl alcohol is a better solvent of the cellulose nitrates than is ethyl alcohol, and in addition will dissolve a wider range of these esters than will the next higher alcohol in this series. It often happens in a series of homologous bodies in organic chemistry that the lowest member exhibits properties entirely different from the rest, so that generalizations as to the deportment of a homologous series can seldom be made with accuracy if based upon that of the lowest member. In this respect methyl alcohol is typical. In general the solvent capacity for the nitric and acetic esters of cellulose diminish with increased molecular weight of alkyl alcohol, i. e.,

1906, **27**, 1907, **28**, 997, abst. Chem. Centr. 1907, **78**, I, 627; II, 1599.

19. Ann. 1873, **169**, 114; 1875, **178**, 342, abst. J. C. S. 1874, **27**, 145, 1876, **29**, 365, Jahr. Chem. 1875, **28**, 281.

20. Zts. physik. Chem. 1900, **33**, 129, Jahr. Chem. 1900, **43**, 786.

21. Monatsh. 1903, **24**, 765, 1908, **29**, 509, 1913, **34**, 779; abst. Jahr. Chem. 1903, **54**, 971, 1905-1908, II, 1098, Chem. Centr. 1904, **75**, I, 158; 1908, **79**, II, 1037; Wein. Akad. Ber. **112**, 606, C. A. 1913, **7**, 2542.

1. Monatsh. 1909, **30**, 729; abst. Chem. Zentr. 1910, **81**, I, 654.

2. Zts. anorg. Chem. 1905, **43**, 53, abst. Chem. Centr. 1905, **76**, I, 498.

3. Wein. Akad. Ber. **111**, 11b, 558, abst. Monatsh. 1902, **23**, 747, Jahr. Chem. 1902, **55**, 1063.

4. Rec. trav. chim. 1910, **29**, 22, Bull. Roy. Belg. 1909, 83, C. A. 1910, **4**, 1484; Jahr. Chem. 1909, **62**, 108.

5. Ann. 1895, **289**, 173; J. C. S. 1896, **70**, i, 317. See Ber. 1892, **25**, 2190; abst. J. C. S. 1892, **62**, 1243.

6. Ber. 1909, **42**, 1960, abst. J. C. S. 1909, **96**, ii, 451.

7. Zts. f. Chem. 1869, **12**, 324, abst. Jahr. Chem. 1869, **22**, 514.

8. Ber. 1901, **34**, 2856; abst. Chem. Centr. 1901, **72**, II, 986.

9. U. S. P. 1030177, 1912, D. R. P. 258057, 1911, abst. C. A. 1913, **7**, 2836.

10. D. R. P. 229678, 1909; abst. J. S. C. I. 1910, **30**, 307; C. A. 1911, **5**, 2535, abst. Chem. Zentr. 1911, **82**, I, 275, Jahr. Chem. 1909, **62**, 326; Wag. Jahr. 1911, **57**, I, 13; Zts. ang. Chem. 1911, **24**, 190; Chem. Ind. 1911, **34**, 82; Chem. Tech. Rep. 1911, **35**, 40. U. S. P. 1082424, 1913; abst. C. A. 1914, **8**, 788; J. S. C. I. 1914, **33**, 103; Mon. Sci. 1914, 66, J. A. C. S. 1909, **31**, 722; abst. Chem. Zentr. 1909, **80**, II, 797.

11. U. S. P. 1075284, 1913; abst. C. A. 1913, **7**, 4046; J. S. C. I. 1913, **32**, 1030.

12. U. S. P. 1003428, 1911; 1066474, 1913, E. P. 11728, 1911; D. R. P. 246967, 1910; Can. P. 136538, 1911; abst. C. A. 1912, **6**, 2529; 1913, **7**, 2994; J. S. C. I. 1913, **32**, 806. The pyroxylin composition of W. Doerflinger (U. S. P. 1320458, 1919; abst. C. A. 1920, **14**, 234) consists of pyroxylin 40 lbs., castor oil 40 lbs., methyl-ethyl ketone 28 gal., *n*-butyl alcohol 25 gal., and benzene 42 gal.

ethyl alcohol being a better solvent for the cellulose esters than the next higher member, propyl alcohol, but such deductions are fallacious when comparing methyl with the higher alcohols in this series. The lower nitrated celluloses are soluble with a small residue in methyl alcohol, but nitrocelluloses may be produced which are entirely soluble in this alcohol. The points of inferiority from a solvent point of view of methyl alcohol is the low boiling point, pronounced hygroscopicity, ready miscibility with water in all proportions without turbidity, and rapid evaporative capacity. Notwithstanding these defects, methyl alcohol is used in immense quantities in pyroxylin mixtures.

The early history of the rise and expansion of the nitrocellulose art is intimately associated with methyl alcohol. In the period from 1850 to 1885 appear the processes and disclosures of J. Schlossberger,¹ M. Plessy and I. Schlumberger,² C. Bercy,³ H. Kenyon,⁴ G. Kraemer,⁵ and J. Stevens,⁶ and in which methyl alcohol forms an essential constituent.

In the period 1886 to 1900 much activity was displayed in determining the physical constants, reactions and solvent behavior of this paraffin alcohol, as reflected in the writings and patents of S. Challoner,⁷ R. Weiss,⁸ W. Hartley,⁹ Eastman Dry Plate and Film Co.,¹⁰ F. Alkier,¹¹ C. Lees,¹² H. Landolt,¹³ J. van Laar,¹⁴ J. Kuenen and W. Robson,¹⁵ G. Kahlbaum,¹⁶ H. Jones,¹⁷

1. Ann. 1849, **73**, 212, abstr. Chem. Centr. 1850, **21**, 437, Jahr. Chem. 1850, **3**, 563.

2. Bull. Soc. Ind. Mulhouse. 1854, 122, abstr. Dingl. Poly. 1855, **131**, 358, Chem. Tech. Mitth. 1852-1854, 165; Poly. Centr. 1854, **20**, 940.

3. U. S. P. 118787, 1871.

4. E. P. 3987, 1882, abstr. J. S. C. I. 1882, **1**, 385, 1883, **2**, 287.

5. Ber. 1880, **13**, 100, Zts. anal. Chem. 1880, **19**, 498, abstr. Chem. Ztg. 1880, **4**, 391, Chem. Ind. 1880, **3**, 284, Jahr. Chem. 1880, **33**, 1207, Chem. Centr. 1880, **51**, 427, Bull. Soc. Chim. 1880, **34**, 618.

6. U. S. P. 269345, 1882, 478543, 1892, abstr. J. Soc. Dyers Col. 1892, **8**, 160; J. A. C. S. 1892, **14**, 289.

7. E. P. 16035, 1888, abstr. J. S. C. I. 1888, **7**, 790, 1889, **8**, 8; 1890, **9**, 84.

8. E. P. 9835, 1888, abstr. J. S. C. I. 1889, **8**, 697.

9. Chem. News, 1892, **66**, 298; J. C. S. 1893, **63**, 250, abstr. Chem. Centr. 1892, **64**, I, 76.

10. D. R. P. 59267; abstr. Ber. 1892, **25**, 261-R.

11. E. P. 1514, 1890; abstr. J. S. C. I. 1890, **9**, 237, 350, 540.

12. Phil. Trans. Roy. Soc. 1898, **191A**, 399, 425, 440, abstr. Zts. physik. Chem. 1899, **28**, 336.

13. See G. Kahlbaum, Zts. physik. Chem. 1898, **26**, 650.

14. Zts. physik. Chem. 1900, **31**, 6; abstr. J. C. S. 1900, **78**, ii, 189.

15. Zts. physik. Chem. 1899, **28**, 356; abstr. J. C. S. 1899, **76**, ii, 356.

16. Zts. physik. Chem. 1898, **26**, 650; abstr. J. C. S. 1898, **74**, ii, 556.

17. Zts. physik. Chem. 1899, **31**, 114; abstr. J. C. S. 1900, **78**, ii, 187.

A. von Hemptinne and A. Bequaert,¹ A. von Hemptinne,² F. Framm,³ P. Drude,⁴ J. Dewar and J. Fleming,⁵ G. Carrara,⁶ J. Brühl,⁷ S. Bigelow,⁸ N. Basset,⁹ R. Abegg and W. Seitz,¹⁰ S. Arrhenius,¹¹ H. Weber,¹² W. Spring,¹³ V. Rothmund,¹⁴ P. Morretto,¹⁵ M. Mond, W. Ramsay and J. Shields,¹⁶ and N. Menshutkin.¹⁷

From 1901 until 1910 the volume and importance of research on this body was considerably augmented by the uses which had been brought to the attention of technicians in this field by the disclosures of their predecessors, and this in turn is shown by the ideas, processes and formulae in which methyl alcohol either alone, but more generally in combination, found use as a solvent in conjunction with other fluids to impart selective properties. The principal steps in advancement chronicled during this period are reflected in the researches of E. Loomis,¹⁸ M. Levi,¹⁹ A. Ladenburg and E. Krugel,²⁰ C. Kullgren,²¹ L. Kahlenberg and A. Lincoln,²² H. Jones and C. Lindsay,²³ H. Jones and F. Getman,²⁴ G.

1. Zts. physik. Chem. 1899, **28**, 231; abst. J. C. S. 1899, **78**, ii, 359.
2. Zts. physik. Chem. 1898, **25**, 285; abst. J. C. S. 1898, **74**, ii, 287.
3. Arch. ges. Physiol. 1897, **68**, 144; abst. Zts. physik. Chem. 1898, **25**, 373.
4. Zts. physik. Chem. 1897, **23**, 267; 1898, **26**, 490; abst. J. C. S. 1897, **72**, ii, 438.
5. Proc. Roy. Soc. 1897, **61**, 358; abst. Zts. physik. Chem. 1898, **24**, 555, 561; **25**, 372.
6. Gazz. chim. ital. 1896, **26**, I, 119; abst. Zts. physik. Chem. 1898, **26**, 571.
7. Zts. physik. Chem. 1899, **30**, 1-63; abst. J. C. S. 1899, **76**, ii, 735; 1900, **78**, ii, 11.
8. Zts. physik. Chem. 1898, **26**, 528; abst. J. C. S. 1898, **74**, ii, 506.
9. E. P. 24013, 1898; abst. Chem. Ztg. 1900, **24**, 240; Mon. Sci. 1900, **56**, 214.
10. Zts. physik. Chem. 1899, **29**, 246; abst. J. C. S. 1899, **76**, ii, 623.
11. Zts. physik. Chem. 1899, **31**, 226, 227; abst. J. C. S. 1900, **78**, ii, 201.
12. Zts. physik. Chem. 1899, **28**, 336. See also Phil. Trans. Roy. Soc. 1897, **191A**, 399.
13. Rec. trav. Chim. Pays-Bas, 1897, **16**, 1; abst. Zts. physik. Chem. 1898, **27**, 177.
14. Zts. physik. Chem. 1898, **26**, 456; abst. J. C. S. 1898, **74**, ii, 503.
15. Nouv. Cimento, 1897, **6**, 198; abst. Zts. physik. Chem. 1899, **28**, 160.
16. Zts. physik. Chem. 1898, **25**, 669; abst. J. C. S. 1898, **74**, ii, 599.
17. See Zts. physik. Chem. 1899, **28**, 677; 1900, **34**, 154.
18. Zts. physik. Chem. 1900, **32**, 588, 589, 591; abst. J. C. S. 1900, **78**, ii, 335.
19. Gazz. chim. ital. 1901, **31**, II, 513; abst. Zts. physik. Chem. 1902, **41**, 110.
20. Ber. 1899, **32**, 1818; abst. Zts. physik. Chem. 1900, **32**, 660.
21. Zts. physik. Chem. 1901, **37**, 618; abst. J. C. S. 1901, **80**, ii, 496.
22. J. Phys. Chem. 1899, **3**, 26; see Zts. physik. Chem. 1903, **43**, 437.
23. Amer. Chem. J. 1902, **28**, 329; abst. Zts. physik. Chem. 1904, **47**, 239.
24. Amer. Chem. J. 1900, **23**, 89, 512; abst. Zts. physik. Chem. 1904, **49**, 454.

Just,¹ G. Heinrich,² J. van't Hoff,³ T. Hanmer,⁴ W. Hoskins,⁵ W. Gilbody and G. Spranklin,⁶ L. Gouy,⁷ P. Guye and L. Fride-
rich,⁸ C. Guldberg,⁹ G. Fraps,¹⁰ H. Euler,¹¹ A. Dunstan,¹² F. Dreyer,¹³
C. Dobson,¹⁴ F. Davis,¹⁵ L. Crismer,¹⁶ M. Centnerszwer,¹⁷ G. Carrara
and M. Levi,¹⁸ G. Carrara and A. Coppadoro,¹⁹ F. Bühler,²⁰ B. de
Bruyn,²¹ F. Brandl and de Baudry D'Asson,²² C. Broughton,²³ P.
Boedke,²⁴ E. Beckmann,²⁵ D. Berthelot,²⁶ K. Bädeler,²⁷ J. P. Amagat,²⁸
S. Young and E. Fortey,²⁹ R. Wolfenstein,³⁰ W. Whatmough,³¹
E. Weed,³² P. Walden,³³ P. Walden and M. Centnerszwer,³⁴ B. Viola

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2. Zts. physik. Chem. 1901, **37**, 227; J. C. S. 1900, **78**, ii, 707.
3. See Zts. physik. Chem. 1904, **49**, 207.
4. E. P. 24326, 1903; abst. J. S. C. I. 1904, **23**, 978.
5. U. S. P. 770463, 1904; abst. J. S. C. I. 1904, **23**, 990, J. A. C. S. 1905, **27R**, 299.
6. J. C. S. 1902, **81**, 787; abst. Zts. physik. Chem. 1903, **43**, 123.
7. Compt. rend. 1901, **133**, 1301, abst. Zts. physik. Chem. 1902, **46**, 172.
8. Arch. sci. phys. Geneva, 1900, **9**, 22, abst. Zts. physik. Chem. 1903, **46**, 172.
9. Zts. physik. Chem. 1900, **32**, 121; abst. J. C. S. 1900, **78**, ii, 264.
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11. Zts. physik. Chem. 1901, **36**, 408, abst. J. C. S. 1901, **80**, ii, 307.
12. Zts. physik. Chem. 1904, **49**, 595; J. C. S. 1904, **85**, 817, **86**, ii, 805.
13. Zts. physik. Chem. 1904, **48**, 472, abst. J. C. S. 1904, **86**, ii, 611.
14. U. S. P. 774135, 1904; abst. J. S. C. I. 1904, **23**, 1111, J. A. C. S. 1905, **27R**, 432.
15. U. S. P. 774649, 1904, 826407, 1906, abst. J. S. C. I. 1904, **23**, 1143, 1906, **25**, 939; Chem. Zts. 1906, **5**, 495.
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17. Zts. physik. Chem. 1904, **49**, 206, abst. J. C. S. 1904, **86**, ii, 706.
18. Gazz. chim. ital. 1900, **30**, II, 197; abst. Zts. physik. Chem. 1901, **36**, 105.
19. Mem. R. Acca. d'Lincci, 1901, 317, abst. Zts. physik. Chem. 1903, **44**, 380.
20. Zts. ang. Chem. 1901, **14**, 610, abst. J. S. C. I. 1901, **20**, 885.
21. Zts. physik. Chem. 1900, **32**, 85, abst. J. C. S. 1900, **78**, ii, 266.
22. E. P. 8023, 1901; abst. J. S. C. I. 1902, **21**, 782.
23. U. S. P. 771706, 1904; abst. Chem. Zts. 1904, **3**, 812, J. S. C. I. 1904, **23**, 1023; J. A. C. S. 1905, **27R**, 373.
24. Zts. physik. Chem. 1904, **48**, 341; abst. J. C. S. 1904, **86**, ii, 542.
25. Zts. physik. Chem. 1900, **34**, 600, abst. J. C. S. 1900, **78**, ii, 71, 1901, **80**, 53, 81.
26. Compt. rend. 1900, **130**, 565; abst. Zts. physik. Chem. 1900, **35**, 103.
27. Zts. physik. Chem. 1901, **36**, 329; abst. J. C. S. 1901, **80**, ii, 220.
28. See C. Guldberg, Zts. physik. Chem. 1900, **32**, 119.
29. J. C. S. 1902, **81**, 739; abst. J. S. C. I. 1902, **21**, 720; Zts. physik. Chem. 1903, **43**, 124.
30. E. P. 11712, 1903; abst. J. S. C. I. 1904, **23**, 430.
31. Zts. physik. Chem. 1901, **39**, 183; abst. J. C. S. 1902, **82**, ii, 125.
32. E. P. 4355, 1903; U. S. P. 804358, 805174, 1905; abst. J. S. C. I.

- and R. Moldenke,¹ S. Tymstra,² M. Stritar and H. Zeidler,³ M. Stritar,⁴ F. Skirrow,⁵ E. Siermann,⁶ A. Schükarew,⁷ W. Sagrebin,⁸ W. Sagrebin and N. Menshutkin,⁹ Rotten,¹⁰ J. Roake,¹¹ R. Reinganum,¹² W. Ramsay and B. Steele,¹³ L. Puccianti,¹⁴ A. Prescott,¹⁵ T. Patterson,¹⁶ W. Perkin and A. Williams,¹⁷ A. Noyes and G. Sammett,¹⁸ S. Mulliken and H. Scudder,¹⁹ R. Müller,²⁰ Z. Minozzi,²¹ K. Meyer,²² J. Mallonee,²³ B. and M. Lyster,²⁴ A. Leach and H. Lythgoe,²⁵ D. Lance and E. Elworthy,²⁶ J. Kuennen,²⁷ W. and T. James,²⁸ W. Harper,²⁹ C. Hammatt,³⁰ J. and B. Galay,³¹ G. Guerin,³² 1903, **22**, 692; 1905, **24**, 1220; 1906, **25**, 12
- 33. Zts. physik. Chem. 1903, **46**, 172, abst. J. C. S. 1904, **86**, ii, 227.
 - 34. Zts. physik. Chem. 1901, **39**, 561, abst. J. C. S. 1902, **82**, ii, 245.
 - 1. U. S. P. 767090, 767091, 1904, abst. J. S. C. I. 1904, **23**, 861.
 - 2. Zts. physik. Chem. 1904, **49**, 353, abst. J. C. S. 1904, **86**, ii, 699.
 - 3. Zts. anal. Chem. 1904, **43**, 387; abst. J. S. C. I. 1904, **23**, 841.
 - 4. Zts. anal. Chem. 1904, **43**, 401; abst. J. S. C. I. 1904, **23**, 841.
 - 5. Zts. physik. Chem. 1902, **41**, 151, 156, abst. J. C. S. 1902, **82**, ii, 600.
 - 6. Chem. Ztg. 1901, **25**, 1158, abst. J. S. C. I. 1902, **21**, 164. Cf. J. S. C. I. 1901, **20**, 977.
 - 7. Zts. physik. Chem. 1903, **44**, 554, 558, abst. J. C. S. 1903, **84**, ii, 710.
 - 8. J. Russ. Phys. Chem. Soc. 1899, **31**, 19; abst. Zts. physik. Chem. 1900, **32**, 640.
 - 9. J. Russ. Phys. Chem. Soc. 1899, **31**, 19, abst. Zts. physik. Chem. 1900, **34**, 151; J. C. S. 1899, **76**, ii, 735; Chem. Centr. 1899, **70**, I, 1059.
 - 10. Rev. Prod. Chim. **3**, 357; abst. J. S. C. I. 1901, **20**, 604.
 - 11. U. S. P. 700373, 1902; abst. J. S. C. I. 1902, **21**, 965.
 - 12. Zts. physik. Chem. 1904, **49**, 703; abst. J. C. S. 1904, **86**, ii, 645.
 - 13. Zts. physik. Chem. 1903, **44**, 353, 365, 366, 705, abst. J. C. S. 1903, **84**, ii, 635.
 - 14. Nouv. Cimento, 1900, **11**, 241; abst. Zts. physik. Chem. 1901, **39**, 371.
 - 15. Pharm. Arch. 1901, **4**, 86; abst. Chem. Ztg. Rep. 1901, **25**, 246; J. S. C. I. 1901, **20**, 1030.
 - 16. J. C. S. 1901, **79**, 167, abst. Zts. physik. Chem. 1901, **37**, 632.
 - 17. E. P. 22381, 1904; F. P. 347446, 1904; abst. J. S. C. I. 1905, **24**, 344, 1028, Chem. Ztg. 1906, **30**, 178, Mon. Sci. 1907, **67**, 110; 1908, **68**, 655.
 - 18. Zts. physik. Chem. 1902, **41**, 15, abst. J. C. S. 1902, **82**, ii, 498.
 - 19. Amer. Chem. J. 1900, **24**, 444, abst. J. S. C. I. 1901, **20**, 71.
 - 20. Zts. ang. Chem. 1910, **23**, 352; abst. Chem. Zentr. 1910, **81**, I, 1275.
 - 21. Gaz. chim. ital. 1899, **29**, I, 421, Zts. physik. Chem. 1900, **32**, 411.
 - 22. Zts. physik. Chem. 1900, **32**, 15, 16, 25, 30; abst. J. C. S. 1900, **78**, ii, 263.
 - 23. U. S. P. 766717, 1904; abst. Chem. Ztg. 1904, **28**, 801, Chem. Zts. 1904, **3**, 738; J. A. C. S. 1905, **27R**, 198.
 - 24. U. S. P. 941641, 1909; abst. Chem. Ztg. Rep. 1910, **34**, 19, J. S. C. I. 1910, **29**, 13.
 - 25. J. A. C. S. 1905, **27**, 964, abst. J. S. C. I. 1905, **24**, 943.
 - 26. E. P. 7297, 1906; abst. J. S. C. I. 1907, **26**, 167; C. A. 1907, **1**, 1193.
 - 27. Phil. Mag. 1903, **6**, 637; abst. Zts. physik. Chem. 1905, **50**, 596.
 - 28. U. S. P. 813302, 1906; abst. J. S. C. I. 1906, **25**, 309; Chem. Zts. 1906, **5**, 185.
 - 29. U. S. P. 789691, 1905; abst. J. S. C. I. 1905, **24**, 613.
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- J. Gyr,¹ G. Frankforter,² Z. Fireash and C. Leonard,³ Z. Fireash,⁴ T. Duffgan,⁵ H. Doughty,⁶ A. Doroszewski and S. Dworzanczyk,⁷ W. Danner,⁸ H. Chute,⁹ J. Bruhl and H. Schroder,¹⁰ N. Whitehouse and N. Beetlestone,¹¹ J. Wolff,¹² H. de Vallande,¹³ R. Strohbach,¹⁴ S. Smith and T. Harden,¹⁵ H. Schmidt,¹⁶ W. Rosenkrans,¹⁷ P. Pikos,¹⁸ Pages, Camus et Cie,¹⁹ Orljavec Chem. Fabrik, J. and A. Müller,²⁰ and E. Orlov.²¹
31. E. P. 19772, 1909; abst J. S. C. I. 1910, **29**, 483.
 32. J. pharm. chim. 1907, **25**, 97; abst J. S. C. I. 1907, **26**, 166.
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 2. U. S. P. 875342, 1907; abst J. S. C. I. 1908, **27**, 115.
 3. U. S. P. 890418, 1908; abst J. S. C. I. 1908, **27**, 743, Chem. Ztg Rep. 1908, **32**, 428.
 4. U. S. P. 789271, 1905; abst J. S. C. I. 1905, **24**, 613.
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 6. U. S. P. 930274, 1909; abst J. S. C. I. 1909, **28**, 993, C. A. 1909, **3**, 2627.
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 8. U. S. P. 883091, 1908; abst J. S. C. I. 1908, **27**, 439.
 9. U. S. P. 824906, 1906; abst J. S. C. I. 1906, **25**, 821. U. S. P. 893784, 1908; abst J. S. C. I. 1908, **27**, 850. U. S. P. 939980, 1909; abst C. A. 1910, **4**, 495, Chem. Ztg. Rep. 1909, **33**, 647, U. S. P. 1250282, 1917; abst C. A. 1918, **12**, 532, J. S. C. I. 1918, **37**, 118-A.
 10. Zts. physik. Chem. 1905, **50**, 10, 34. See also Ber. 1902, **35**, 4030; 1904, **37**, 2512.
 11. E. P. 4274, 1906; abst J. S. C. I. 1907, **26**, 113, C. A. 1907, **1**, 927.
 12. Bull. Assoc. Chim. Suer. Dist. 1907, **24**, 1623; abst J. S. C. I. 1907, **24**, 939.
 13. F. P. 372903, 1906; abst J. S. C. I. 1907, **26**, 522.
 14. F. P. 386424, 1908; and addition dated June 10, 1908; abst J. S. C. I. 1908, **27**, 679, 1105.
 15. F. P. 369616.
 16. U. S. P. 885183, 1908; abst J. S. C. I. 1908, **27**, 496, Mon. Sci. 1908, **69**, 120; C. A. 1908, **2**, 2618.
 17. U. S. P. 793542, 1905; abst. J. A. C. S. 1906, **28R**, 80; J. S. C. I. 1905, **24**, 838.
 18. Zts. ang. Chem. 1909, **22**, 2036; abst J. S. C. I. 1909, **28**, 1118.
 19. F. P. 375314, 1906; and addition dated April 3, 1907; abst. J. S. C. I. 1907, **26**, 920; 1908, **27**, 679.
 20. F. P. 357432, 1905; abst J. S. C. I. 1906, **26**, 117, C. A. 1907, **1**, 639, 665; Mon. Sci. 1906, **65**, 126; Chem. Zts. 1906, **5**, 17.
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From 1910 up to the present time the activities in this field of cellulose ester usefulness have, in general, been mainly confined to devising suitable combinations of the low methyl alcohol with high boilers and plastifying combinations, in order to take advantage of the solvent power of the methyl alcohol, while at the same time minimizing the objectionable properties caused by the speedy evaporation and well marked hygroscopicity. As representative of the tendencies in recent years may be cited the contributions of B. Lacy,¹ F. Körber,² T. Kennedy and F. Heckel,³ P. Klason, G. von Heidenstam and E. Norlin,⁴ Sauerstoff u. Stickstoff Ind. Hansmann & Co.,⁵ Holzverkohlungs-Industrie Akt.-Ges.,⁶ C. Henry,⁷ J. Hetper,⁸ L. Hawley,⁹ L. Hawley and R. Palmer,¹⁰ H. Gibbs,¹¹ T. von Fellenberg,¹² S. Dushman and J. Bain,¹³ G. Denigès,¹⁴ J. Christensen,¹⁵ J. Christiansen,¹⁶ W. Bone and L. Davies,¹⁷ J. Blanksma,¹⁸ E. Bertini,¹⁹ F. Baker,²⁰ C. Basker-

Zentr. 1908, **79**, I, 114; II, 1499, J. S. C. I. 1908, **27**, 139, 1176. See also J. S. C. I. 1907, **26**, 544.

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2. *Anf. Physik* 1912, **37**, 1021; abst. J. C. S. 1912, **102**, ii, 538.

3. U. S. P. 969635, 1910, abst. J. S. C. I. 1910, **29**, 1195; C. A. 1910, **4**, 3296; *Chem. Ztg. Rep.* 1910, **34**, 515.

4. *Zts. ang. Chem.* 1910, **23**, 1252; abst. J. S. C. I. 1910, **29**, 871. See also *Arkiv. Kemi. och Geol.* 1908, **3**, 1; abst. *Chem. Zentr.* 1909, **80**, I, 109, J. S. C. I. 1909, **28**, 132.

5. Aust. P. 47233, 1911; D. R. P. 214155; abst. *Chem. Zentr.* 1909, **80**, II, 1510; C. A. 1910, **4**, 496.

6. F. P. 45345, 1913, and addition dated April 26, 1913; abst. J. S. C. I. 1913, **32**, 937, 1059.

7. F. P. 469903, 1913; abst. J. S. C. I. 1915, **34**, 72.

8. *Zts. Nahr. Genussm.* 1912, **24**, 731; abst. J. S. C. I. 1913, **32**, 103.

9. U. S. P. 1106707, 1914, abst. C. A. 1914, **8**, 3362; *Mon. Sci.* 1914, **81**, 186.

10. Eighth Inter. Cong. Appl. Chem. 1912, IV, **6**, 138; *Bull. No.* 129, U. S. Dept. Agric. Sept. 10, 1914; abst. J. S. C. I. 1912, **31**, 865.

11. *Philippine J. Sci.* 1912, **7**, 57; abst. J. S. C. I. 1912, **31**, 1053.

12. *Mitt. Lebensm. Hyg.* 1914, **5**, 172; abst. C. A. 1914, **8**, 3481.

13. J. S. C. I. 1913, **32**, 554.

14. *Bull. Soc. Chim.* 1910, **7**, 951; abst. J. S. C. I. 1910, **29**, 1325. See also *T. Sabalitschka, Pharm. Zentralh.* 1920, **61**, 78; abst. J. S. C. I. 1920, **39**, 245-A, C. A. 1920, **14**, 1947. G. Jones, *Chem. Ztg.* 1915, **39**, 389.

15. F. P. 25419, 1913; 13260, 1914; abst. J. S. C. I. 1914, **33**, 1226 1915, **34**, 199; *Ann. Rep. Soc. Chem. Ind.* 1916, **1**, 169.

16. U. S. P. 1302011, 1919; F. P. 125946, 1919; abst. J. S. C. I. 1919, **38**, 877-A; 1920, **39**, 850-A; C. A. 1919, **13**, 1861, 2219. Can. P. 193945 1919. Dan. P. 24647, 1919; abst. C. A. 1920, **14**, 1122. Norw. P. 30784, 1919.

17. J. C. S. 1914, **105**, 1691; abst. J. S. C. I. 1914, **33**, 766.

18. *Chem. Weekblad*, 1913, **11**, 26; abst. *Chem. Zentr.* 1914, **85**, 1.

- ville,¹ K. Arndt,² J. Timmermans,³ R. Vivario,⁴ C. Volney,⁵ D. Tsakalotús,⁶ O. Stern,⁷ C. Schaffer,⁸ E. Richter,⁹ A. Rinck,¹⁰ T. Rigby, G. Andrew and Wetcarbonizing, Ltd.,¹¹ P. Raikow,¹² H. Rasche,¹³ L. Pissarszewski and P. Trachoniotowski,¹⁴ R. Palmer,¹⁵ "Montania" Brennverwertung Ges.,¹⁶ C. Manzoff,¹⁷ J. Lawrence,¹⁸ 574; J. S. C. I. 1914, **33**, 329.
19. F. P. 443065, 1912; E. P. 2317, 1912, abst. J. S. C. I. 1912, **31**, 864, 977.
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1. J. Ind. Eng. Chem. 1913, **5**, 768, abst. C. A. 1913, **7**, 3660; J. S. C. I. 1914, **33**, 768. Methyl alcohol is also known under the names of "Columbian Spirits," "Colonial Spirits," "Manhattan Spirits," "Green Wood Spirits," "Standard Wood Spirits," "Pro Spirit," "Wood Spirit," "Wood Naphtha," "Pyroxylic Spirit," "Centennial Spirits," "Synthol," "Eagle Spirits," "Hastings Spirits," "Wood Alcohol," etc.
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3. Sci. Proc. Roy. Dubl. Soc. 1912, **13**, 326, Bull. soc. chim. Belg. 1912, **26**, 207.
4. J. Pharm. Chim. 1914, **10**, 145; abst. J. S. C. I. 1914, **33**, 935.
5. U. S. P. 1052446, 1913; abst. C. A. 1913, **7**, 1083, Chem. Ztg. Rep. 1913, **37**, 232; Mon. Sci. 1913, **79**, 102.
6. Zts. physik. Chem. 1910, **71**, 669, abst. J. C. S. 1910, **98**, ii, 266.
7. Zts. physik. Chem. 1912, **81**, 441, abst. Chem. Zentr. 1913, **84**, I, 767.
8. U. S. Nav. Bull. **6**, 392, abst. C. A. 1913, **7**, 534.
9. Spiritol, claimed to be ethyl alcohol, is methyl alcohol, Apoth. Ztg. 1910, **25**, 136; abst. C. A. 1910, **4**, 1895.
10. Zts. Nahr. Genussm. 1914, **28**, 98; abst. C. A. 1915, **9**, 123.
11. E. P. 10981, 1913; abst. J. S. C. I. 1914, **33**, 852; C. A. 1914, **8**, 3501.
12. Eighth Inter. Cong. Appl. Chem. 1912, IV, **25**, 417; abst. J. S. C. I. 1913, **32**, 547.
13. U. S. P. 962668, 1910, abst. J. S. C. I. 1910, **29**, 935, Chem. Ztg. Rep. 1910, **34**, 474; C. A. 1910, **4**, 2508.
14. J. Russ. Phys. Chem. Soc. 1910, **42**, 287, abst. C. A. 1911, **5**, 611.
15. U. S. P. 1259277, 1271071, 1918; abst. C. A. 1918, **22**, 1419, 1920.
16. J. S. C. I. 1918, **37**, 295-A, 540-A; Mon. Sci. 1918, **85**, 570. See also Oil, Paint and Drug Rep. March 9, 1914; abst. C. A. 1914, **8**, 2480.
17. E. P. 9499, 1913; abst. C. A. 1914, **8**, 3359; J. S. C. I. 1914, **33**, 304. See also Deutsche Petroleum A.-G., D. R. P. Ann. K-65223, 1917.
18. Zts. Nahr. Genussm. 1914, **27**, 469; abst. C. A. 1914, **8**, 2448; J. S. C. I. 1914, **33**, 497. Other names for methyl alcohol are "methanol," "wine

Laskowsky,¹ V. Krieble,² S. Kanamari,³ G. Jones,⁴ J. Johnson,⁵ E. Hudson and H. Merriam,⁶ K. Hofmann and H. Schibsted,⁷ A. Gettler and A. George,⁸ J. Gendreau,⁹ G. Fendler,¹⁰ E. Fischer,¹¹ J. Ehman,¹² H. Dreyfus,¹³ C. Campbell,¹⁴ H. Bergström,¹⁵ W. Zimmermann,¹⁶ H. Wolff,¹⁷ A. White and J. Rue,¹⁸ E. Szarvasy,¹⁹ E. Salkowski,²⁰ Sailer,²¹ T. Sabalitschka,²² G. Reif,²³ P. Poore,²⁴ M.

of wood," "methyl hydroxide," "carbinol," "pyroligneous spirits of alcohol." For the methyl alcohol production of various countries, see Oil, Paint and Drug Rep. Dec. 19, 1910; abst. J. S. C. I. 1911, **30**, 13. Chem. & Drug. Aug. 26, 1911; abst. J. S. C. I. 1911, **30**, 1196. J. Roy Soc Arts, July 7, 1911; abst. J. S. C. I. 1911, **30**, 883. Oil, Paint and Drug Rep. Dec. 4, 1911; abst. C. A. 1912, **6**, 1523; J. S. C. I. 1911, **30**, 1444.

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1. Chem. Ztg. 1919, **43**, 51; abst. J. S. C. I. 1919, **38**, 193-A.
2. Paper, Ann. Conv. No., 1919, **23**, 153; abst. J. S. C. I. 1919, **38**, 571-A.
3. Jap. P. 32245, 1918; abst. C. A. 1918, **12**, 2247.
4. Analyst, 1915, **40**, 218; abst. C. A. 1915, **9**, 1887.
5. U. S. P. 1151597, 1915; abst. J. S. C. I. 1915, **34**, 1005; C. A. 1915, **9**, 2813.
6. U. S. P. 1303321, 1919; abst. J. S. C. I. 1919, **38**, 494-A; C. A. 1919, **13**, 1925.
7. Ber. 1918, **51**, 1398; abst. J. S. C. I. 1918, **37**, 782-A.
8. Amer. J. Pharm. 1918, **90**, 280; abst. J. S. C. I. 1918, **37**, 318-A.
9. U. S. P. 1276613, 1918; abst. C. A. 1918, **12**, 2126; J. S. C. I. 1918, **37**, 647-A; Mon. Sci. 1919, **86**, 29.
10. Zts. Nahr. Genussm. 1915, **30**, 228; Chem. Ztg. Rep. 1916, **40**, 185; abst. J. S. C. I. 1916, **35**, 702.
11. Kunst. 1916, **6**, 210, 225, 244, 259; abst. C. A. 1919, **13**, 1316.
12. Amer. J. Pharm. 1919, **91**, 594; abst. C. A. 1919, **13**, 2833; J. S. C. I. 1919, **38**, 874-A.
13. E. P. 108855, 1917; abst. C. A. 1918, **12**, 155.
14. U. S. P. 1192987, 1916; abst. C. A. 1916, **10**, 2402; J. S. C. I. 1916, **35**, 951.
15. U. S. P. 1129542, 1915; abst. C. A. 1915, **9**, 1113. H. Bergstrom, O. and K. Fagerlind, and E. Almgren, U. S. P. 1032982, 1909.
16. Pharm. Zentrallh. 1919, **60**, 175; abst. C. A. 1919, **13**, 3113; J. S. C. I. 1919, **38**, 504-A.
17. Chem. Ztg. 1919, **43**, 555; abst. J. S. C. I. 1919, **38**, 874-A. For heats of combustion of methyl, ethyl, propyl, butyl, isobutyl alcohols, and cyclohexanol, see T. Richards and H. Davis, J. A. C. S. 1920, **42**, 1606, 1607.
18. Tech. Assoc. Pulp Paper Ind. New York, Feb. 7, 1917, Met. Chem. Eng. 1917, **16**, 182; abst. J. S. C. I. 1917, **36**, 383.
19. U. S. P. 1181697, 1916; abst. C. A. 1916, **10**, 1693; J. S. C. I. 1916, **35**, 707.
20. Zts. Nahr. Genussm. 1918, **36**, 262; abst. J. S. C. I. 1919, **38**, 382-A; C. A. 1919, **13**, 3113.
21. Pharm. Zentrallh. 1917, **59**, 514; Schweizer Apoth. Ztg. 1918, **56**, 145; abst. C. A. 1918, **12**, 1276.
22. Ber. pharm. Ges. 1919, **29**, 214; abst. C. A. 1919, **13**, 2654.
23. Arbeit. Kais. Gesundheitsamt, 1915, **50**, 50; Zts. ang. Chem. 1916, **29**, 11, 82; J. S. C. I. 1916, **35**, 432. See also A. Classen, E. P. 142480, 1920.
24. E. P. 131006; abst. J. S. C. I. 1919, **38**, 711-A.

Polinski,¹ W. Perry,² U. Pazierni,³ G. Maue,⁴ T. Morson,⁵ H.

1. Chem. Analyst, 1919, **28**, 11; abst. C. A. 1919, **13**, 3113.
2. E. P. 122925; abst. J. S. C. I. 1919, **38**, 215-A.
3. Ann. chim. appl. 1915, **3**, 279; abst. C. A. 1915, **9**, 2206.
4. Zts. Nahr. Genussm. 1919, **35**, 179, abst. C. A. 1919, **13**, 2833.
5. J. S. C. I. 1918, **37**, 26-T. For further information on the toxicity of methyl alcohol, consult L. Poincare, Compt. rend. 1879, **87**, 682. J. Pohl, Arch. Exptl. Path. Pharm **31**, 281; abst. Chem. Centr **1803**, **64**, ii, 380. T. Bokorny, Pfluger's Archiv 1897, **66**, 114. Patillo and Colbourn, Ophthalm Rec. 1899. R. Muller, Zts ang Chem 1910, **23**, 351. L. Lewin, Apoth. Ztg. 1911, **26**, 54, abst. Chem. Zentr 1911, **82**, 1, 672. Med. Klink, 1912, No. 3, 95. R. Forster, Zts. Spiritusind 1910, **33**, 2, abst. Bied Zentr 1911, **40**, 431; Chem. Zentr. 1910, **81**, I, 753, Munch. med. Wochenschr. 1912, 148. L. Sabbatani, Pharm. Inst. Parma Arch. fisiol. (Fano's Festschrift), 1910, **7**, 49; abst. Zentr. Biochem. Biophys **10**, 621. See also Pharm. Zentralh. 1911, **52**, 335. Horbaczewski, Oesterr. Chem. Ztg. 1911, **14**, 139; abst. J. S. C. I. 1911, **30**, 826. G. Cornalba, Boll. Chim. Farm. 1912, **51**, 37, abst. C. A. 1912, **6**, 2134. J. Boeseken and H. Waterman, Chem. Weekblad, 1912, **9**, 694; abst. C. A. 1913, **7**, 497. G. Franceschi, Giogr. farm. chim. 1912, **61**, 145, abst. C. A. 1912, **6**, 1952, 1913, **7**, 384. O. Schmiedeberg, Therap. Monats. 1912, **26**, 329; abst. C. A. 1912, **6**, 2650. T. Tyver and F. Gosling, Yearbook Pharm. 1912, 434. E. Harnack, Deut. med. Wochenschr. 1912, **38**, 358; abst. C. A. 1912, **6**, 1180. F. Mendel, Berl. Ophth. Ges. 1912, 25, 1912, Zentr. Biochem. Biophys **12**, 941, Deut. med. Wochenschr. 1912, 339, abst. C. A. 1912, **6**, 3128. W. Voltz and W. Dietrich, Biochem. Zts. 1912, **40**, 15; abst. C. A. 1912, **6**, 1783. A. Juckenack, H. Prause, Griebel, Jacobsen and Gaza, Zts. Nahr. Genussm. 1912, **24**, 7, abst. C. A. 1912, **6**, 3490. M. Nieloux, Eighth Inter. Cong. Appl. Chem. 1912, **19**, 239, Compt. rend. Soc. biol. 1914, **73**, 59, abst. C. A. 1912, **6**, 3120. D. Whitney, Amer. J. Physiol. 1912, **30**, 463. A. Ruble, Munch. med. Wochenschr. 1912, **59**, 964; abst. C. A. 1912, **6**, 1781. H. Tyson, Arch. Ophth. 1912, abst. Zentr. Biochem. Biophys **15**, 205. C. A. 1913, **7**, 3794. F. Grignolo, Klin. Monatsbl. Augenheilk. 1912, **51**, 157, Zentr. Biochem. Biophys **14**, 889; abst. C. A. 1913, **7**, 2627. I. Kasass, Zentr. Biochem. Biophys **15**, 205; abst. C. A. 1913, **7**, 3794. M. Segale, Accad. med. Genova, 1912, Zentr. Biochem. Biophys **14**, 446, Berl. Klin. Wochenschr. 1913, **50**, 255, abst. C. A. 1913, **7**, 1765. M. Nieloux and A. Placet, J. Physiol. Path. Gen. 1912, **14**, 916, Compt. rend. Soc. biol. 1913, **73**, 63; abst. C. A. 1913, **7**, 1234, 3166, 1914, **8**, 178. L. Buerger, Chem. Ztg. 1912, **36**, 524, abst. C. A. 1913, **7**, 838; Wochenschr. Therapie u. Hyg. des Auges, 1912, 250, Ber. klin. Wochenschr. 1912, 1705. A. Langgard, Berl. klin. Wochenschr. 1912, **49**, 1704, abst. Chem. Zentr. 1912, **83**, II, 1382, C. A. 1913, **7**, 2433. G. Franceschi, Boll. Chim. Farm. 1912, **51**, 325, abst. C. A. 1912, **6**, 1952, 1913, **7**, 384. J. Hirschberg, Berl. klin. Wochenschr. 1912, **49**, 245, abst. C. A. 1913, **7**, 159. S. Miura, Biochem. Zts. 1913, **49**, 144. F. Olvari, Arch. farmacol. speriment. 1913, **15**, 83, abst. Chem. Zentr. 1913, **84**, I, 1780, C. A. 1913, **7**, 2065. A. Loewy and R. von der Heide, Biochem. Zts. 1914, **65**, 230, abst. C. A. 1914, **8**, 3597. See also Pharm. Notizbl. 1914, 23, Apoth. Ztg. 1914, **29**, 639, Pharm. J. **93**, 349. J. Igersheimer and F. Verzar, Arch. Augenheilk. 1914, **75**, 27; abst. Zentr. Biochem. Biophys **15**, 942, C. A. 1914, **8**, 167. L. Kroeber, Pharm. J. 1914, **91**, 532; J. Pharm. Chim. 1913, **8**, 371; Pharm. Zentralh. 1912, **54**, 825; C. A. 1914, **8**, 1169. J. Krol, Arch. exp. Path. Pharm. 1914, **72**, 444; abst. C. A. 1914, **8**, 1999. T. von Fellenberg, Mitth. Lebensm. Hyg. 1915, **6**, 24; abst. C. A. 1915, **9**, 504. H. Tyson and M. Schönberg, Sect. Ophth. Am. Med. Assoc., June 1914, Klin. Monatsbl. Augenheilk. 1914, **53**, 252, Zentr. Biochem. Biophys **15**, 17, 663; C. A. 1914, **8**, 3505; 1915, **9**, 2942. H. Chabanier and E. Ibarra-Loring, Compt. rend. Soc. biol. 1915, **79**, 8; abst. C. A. 1916, **10**, 1897. Ruggeri, Liguria

Wolff,¹ R. Lillig,² K. Hofmann,³ H. Chute,⁴ W. Brandt and F. Root,⁵ P. Hasse,⁶ C. Baskerville,⁷ A. White,⁸ and S. Schryver and C. Wood.⁹

Ethyl Alcohol. The use of ethyl alcohol, especially in combination with ethyl ether, was employed at the inception of the pyroxylin art, the pharmaceutical "ether glue" of Schönbein and the early photographic collodions being the lower nitrated nitro-cottons in ether and alcohol. It was early recognized that the volatility and hygroscopicity of many of the lower boiling solvents were serious drawbacks to their use in conjunction with the nitrocelluloses, and ethyl alcohol being easily obtainable and at a not prohibitive price, was a readily available solvent upon which to make cellulose ester solubility experiments.¹⁰

The early endeavors to utilize ethyl alcohol for this purpose, and other purposes associated with this subject, are to be found during the period up to 1880, in the publications of H. Hyde,¹¹ A. Gesner,¹² F. Haack,¹³ E. Cotelle,¹⁴ B. I.,¹⁵ J. Neely and S. Allen,¹⁶ H. Lamotte,¹⁷ W. Ford, J. Bruns and L. Clark,¹⁸ C. Falkman,¹⁹

med. 7, 187; abst. Zentr. Biochem. Biophys. 1915, **18**, 461. E. Rost, Med. Klinik. 1912, 129; Strassmann, Deut. Medizinal-Ztg. 1912, 81. Ohlemann, Wochenschr. Ther. u. Hyg. des Auges, 1912, 157. Grunow, Med. Reform, 1912, No. 2; Deut. Medizinal-Ztg. 1912, 243. W. Voltz, Med. Klinik. 1912, 697; abst. Biochem. Zts. 1912, **40**, 15. Keferstein, Zts. Medizinalbeamte, 1912, No. 7. Pick, Berl. Klin. Wochenschr. 1912, 888. K. von Buchka, Klin.-therap. Wochenschr. 1912, 674; Berl. klin. Wochenschr. 1912, 2128. Schlichting, Mediz. Klinik. 1912, 1316. C. Lennhoff, Soziale Hyg. u. prakt. Med. 1912, No. 3. Stadelmann, Zts. ärztl. Fortbildung, 1912, No. 16, No. 17.

1. Chem. Ztg. 1919, **43**, 555; abst. C. A. 1920, **14**, 1504.

2. Pharm. Ztg. 1919, **64**, 423, 431; abst. C. A. 1920, **14**, 390.

3. D. R. P. 316216, 316217; abst. J. S. C. I. 1920, **39**, 313-A.

4. U. S. P. 824906, 1906; abst. Chem. Zts. 1906, **5**, 495; C. A. 1907, **1**, 104, 114.

5. U. S. P. 713552, 1902; abst. J. A. C. S. 1903, **25R**, 290.

6. Pharm. Zentralh. 1920, **61**, 177; abst. J. S. C. I. 1920, **39**, 345-A.

7. N. Y. Med. J. 1920, **111**, 580; abst. C. A. 1920, **14**, 1753.

8. Can. P. 175849.

9. Analyst, 1920, **45**, 164; abst. J. S. C. I. 1920, **39**, 466-A. See also J. S. C. I. 1918, **37**, 257-R. "Wyoming spirits" is a trade name for a deodorized wood alcohol.

10. H. Leffman, Power, **27**, 308; abst. C. A. 1907, **1**, 1614.

11. E. P. 2864, 1855.

12. U. S. P. 12936, 12987, 1855.

13. U. S. P. 45001, 45002, 1864.

14. U. S. P. 41685, 1864.

15. Rep. chim. appl. 1862, **4**, 465.

16. U. S. P. 66108, 1867.

17. U. S. P. 59149, 1866.

18. U. S. P. 80860, 1868.

19. U. S. P. 50884, 1865.

P. Martin,¹ and J. Collins,² including the memoir of L. Henry.³

In the decade, 1881-1890 much activity is apparent along lines of endeavor to treat and utilize ethyl alcohol for solvent purposes, especially in connection with the nitrocellulose and celluloid industries. The advancement is reflected in the memoirs and patented processes of L. Naudin,⁴ J. Heindl,⁵ D. Savalle,⁶ L. Schwab,⁷ J. Stelzner,⁸ Dujardin,⁹ P. Claes,¹⁰ S. Rössler,¹¹ J. Pinetta,¹² Negreano,¹³ W. Horne,¹⁴ A. Hoffmann,¹⁵ G. Kraemer and L. Löwenherz,¹⁶ C. Pielsticker,¹⁶ C. Schmitt,¹⁷ W. Squire,¹⁸ Soc. Franc. des Alcools pure,¹⁹ G. Jordan,²⁰ H. Grote,²¹ L. Godefroy,²² H. Deininger,²³ E. Claudon and E. Morin,²⁴ J. Bendix,²⁵ I. Bang and

1. U. S. P. 80646, 1868.
2. U. S. P. 59891, 1866. See also Poly. Notizbl. 1866, **21**, No. 16; abst. Deut. Industrie-Ztg. 1866, 288; Chem. Tech. Mitth. 1866-1867, 272.
3. Ann. Soc. Sci. Bruxelles, 1878; abst. Jahr. Chem. 1878, **31**, 516. See also Ber. 1877, **10**, 2041, abst. Jahr. Chem. 1877, **30**, 324, Chem. Centr. 1878, **49**, 79.
4. Bull. Soc. Chim. 1883, **39**, 626; abst. Chem. Centr. 1883, **54**, 432, 638. See also L. Naudin and J. Schneider, D. R. P. 13944, 1880; abst. Wag. Jahr. 1881, **27**, 819; Chem. Ind. 1881, **4**, 179; Chem. Tech. Jahr. 1881, **4**, 238.
5. Wien Anz. 1881, 61; Monats. 1881, **2**, 200; abst. Bull. Soc. Chim. 1881, **36**, 340; Chem. Centr. 1881, **52**, 308. Wien. Akad. Ber. 1881, **83**, II, 533; abst. Jahr. Chem. 1882, **35**, 211.
6. U. S. P. 266902, 1882.
7. Rec. trav. Chim. Pays-Bas, 1883, **2**, 46; abst. Chem. Centr. 1883, **54**, 403, 417.
8. U. S. P. 294285, 1884; abst. J. A. C. S. 1884, **6**, 144.
9. Dingl. Poly. 1879, **234**, 406; abst. Chem. Centr. 1880, **51**, 172.
10. U. S. P. 267836, 1882. Belg. P. 56408, 1881. P. Claes and Societe Raucq, F. P. 146273, 1881; abst. Mon. Sci. 1882, **24**, 709.
11. E. P. 3352, 1880. See also Text. Rec. **2**, 16.
12. U. S. P. 384868, 1888.
13. Compt. rend. 1888, **106**, 1665; **107**, 173; abst. Chem. Centr. 1888, **59**, 1053, 1149.
14. U. S. P. 419332, 1889; abst. J. A. C. S. 1890, **12**, 20.
15. Chem. Ind. 1889, **12**, 193, 521; abst. Wag. Jahr. 1889, **35**, 593. See also Wag. Jahr. 1888, **34**, 1075.
16. U. S. P. 412931, 1889.
17. Zts. Spiritusind. **12**, 284; abst. Chem. Centr. 1889, **60**, 951.
18. J. S. C. I. 1889, **8**, 441; abst. Chem. Centr. 1889, **60**, II, 423.
19. E. P. 6869, 1888; abst. J. S. C. I. 1888, **7**, 415, 882; 1889, **8**, 57.
20. U. S. P. 358615, 1887.
21. E. P. 2109, 1887; abst. J. S. C. I. 1887, **6**, 159, 849; 1888, **7**, 129.
22. Compt. rend. 1888, **106**, 1018; abst. Chem. Centr. 1888, **59**, 692.
23. D. R. P. 30843, 35510; abst. Wag. Jahr. 1886, **32**, 829; Tech. Chem. Jahr. 1884, **7**, 300; 1886, **9**, 342.
24. Bull. Soc. Chim. 1888, **49**, 178; abst. Chem. Centr. 1887, **58**, 699; 1888, **59**, 349.
25. U. S. P. 333721, 1886.

M. Ruffin,¹ J. Traube and G. Bodländer,² T. Bowick,³ X. Rocques,⁴ and W. Ramsay and S. Young.⁵

From 1891 to the close of the century increased interest is apparent along all endeavors to supplant the more expensive amyl alcohol and esters for the relatively inexpensive ethyl alcohol as such and when esterified. Activity in the manufacture of this alcohol rapidly widened in scope and investigators. The principal steps in advancement are reflected in the publications of E. Maunfé,⁶ A. Mitscherlich,⁷ W. Hartley,⁸ A. Springer,⁹ G. Guignard and A. Hedquin,¹⁰ G. Guignard,¹¹ E. Barbet,¹² E. Waller,¹³ F. Broyer and P. Petit,¹⁴ A. Villon,¹⁵ A. Trilat and R. Cambier,¹⁶ L. Backeland,¹⁷ J. Bell,¹⁸ A. Tedesco,¹⁹ P. Rousseau, M. de Charterac and M. de la Baume,²⁰ P. Magnier,²¹ Loock,²² G. Sandlser,²³ J. Lang,²⁴ A. Henry,²⁵ P. Head,²⁶ P. Paulet,²⁷ F. Pampe,²⁸

1. U. S. P. 314910, 1885.
2. E. P. 8387, 1887; abst. J. S. C. I. 1887, **6**, 472; 1888, **7**, 364, 449.
3. U. S. P. 391015, 1888.
4. Compt. rend. 1888, **106**, 1296; abst. Chem. Centr. 1888, **59**, 809.
5. Zts. physik. Chem. 1889, **3**, 63.
6. Compt. rend. 1894, **119**, 1014; abst. Chem. Centr. 1895, **66**, I, 306.
7. E. P. 12927, 1893. See also E. Bronnert and T. Schlumberger, E. P. 6858, 1896; abst. Arms & Explo. 1897, **5**, 139.
8. J. C. S. 1893, **63**, 250; abst. Ber. 1894, **27**, 20 R. Cf. Phil. Trans. 1879, **170**, 257.
9. U. S. P. 457799, abst. J. A. C. S. 1891, **13**, 223.
10. U. S. P. 436735, 1890, abst. J. A. C. S. 1890, **12**, 364.
11. U. S. P. 432198, 1890, abst. J. A. C. S. 1890, **12**, 355.
12. U. S. P. 436764, 1890, abst. J. A. C. S. 1890, **12**, 364. Belg. P. 143854, 1899, 143918, 1899; 146215, 1899; 151333, 1900, 244384, 1912. U. S. P. 1292676; abst. C. A. 1919, **13**, 963.
13. Chem. News, 1890, **61**, 53; abst. Chem. Centr. 1890, **61**, I, 420; Jahr. Chem. 1890, **43**, 2801.
14. U. S. P. 468326, 1892.
15. Bull. Soc. Chim. 1893, **9**, 639; abst. Chem. Centr. 1893, **64**, II, 629.
16. Compt. rend. 1894, **118**, 1277; abst. Chem. Centr. 1894, **65**, II, 78.
17. J. A. C. S. 1892, **14**, 212.
18. J. S. C. I. 1893, **12**, 236; abst. Chem. Centr. 1893, **64**, I, 906.
19. E. P. 9054, 1894, abst. J. S. C. I. 1894, **13**, 896.
20. U. S. P. 470447, 1892, abst. J. A. C. S. 1892, **14**, 73.
21. Belg. P. 139852, 1898.
22. Zts. offentl. Chem. 1898, 316; abst. Wag. Jahr. 1898, **44**, 963. See also H. Herzfeld, Zts. offentl. Chem. 1898, 389.
23. Belg. P. 143063, 144800, 1899.
24. D. R. P. 94627; abst. Wag. Jahr. 1898, **44**, 959; Chem. Centr. 1898, **69**, I, 591; Chem. Ztg. 1898, **22**, 13. See also Zts. Spiritusind. 1897, 10; Mon. Sci. 1897, **49**, 564. Cf. Heinzelmann, Zts. Spiritusind. 1897, 19. See also Zts. ang. Chem. 1897, **10**, 158.
25. Belg. P. 136942, 1898.
26. Belg. P. 142144, 1899.
27. Belg. P. 129414, 1897.
28. Belg. P. 125652, 1897.

O. Perrier,¹ M. Pridham,² E. Signonsen,³ J. Sinibaldi,⁴ A. Skassa,⁵ Soc. anôn. pour la Construction des Appareils Savalle,⁶ Soc. civile pour l'Exploitation de Brevets,⁷ R. Ilges,⁸ L. Droulers, R. Genge and V. Ragon,⁹ P. Cazeneuve and A. Morel,¹⁰ A. Classen,¹¹ C. Crepelle-Fontaine,¹² L. Cuvillier,¹³ P. Coudert,¹⁴ E. Zdzarek,¹⁵ A. Collette and A. Boidin,¹⁶ J. Bennett,¹⁷ E. and L. Wallaert,¹⁸ E. Bauer,¹⁹ Alcohol Syndicate, Ltd.,²⁰ B. Attebury, T. Macalpine and Alcohol Syndicate, Ltd.²¹

In contradistinction to the development of the solvent properties of fusel oil and amyl alcohol, where there was an apparent quiescence in activity along about 1900, interest in ethyl alcohol appears to have increased rather than waned in the period 1901-1910, as evidenced by the following selection of contributions bearing directly or indirectly upon the solvent capacity of this alcohol, both alone and in combination.

J. Dornig,²² M. Cari-Mantrand,²³ R. Duchemin,²⁴ J. Carrol,²⁵

- 1 U. S. P. 537786, 1895 Belg. P. 170149, 168698, 1903
- 2 U. S. P. 574111, 1896 See also F. Bowly, U. S. P. 866426, 1907
- 3 Norsk teknisk Tidsskr. 1895, 65, abst. Bied Centr. 1896, **25**, 47; J. C. S. 1896, **70**, i, 331 Zts. ang. Chem. 1903, **16**, 572, abst. J. S. C. I. 1903, **22**, 814; see also J. S. C. I. 1898, **17**, 365, 481, 1164 Norw. P. 23679, 1912; abst. C. A. 1914, **8**, 777 D. R. P. 285190, 1913, abst. J. S. C. I. 1915, **34**, 1161
- 4 Belg. P. 125943, 1897.
- 5 Belg. P. 136287, 1898
- 6 Belg. P. 137777, 1898
- 7 Belg. P. 137388, 1898
- 8 Belg. P. 136757, 1898
- 9 Belg. P. 137080, 1898 See L. Bouveault and G. Blanc, U. S. P. 868252, 1907
- 10 Bull. Soc. Chim. 1889, **1**, 700, 1898, **19**, 694, Compt. rend. 1893, **116**, 148; 1898, **126**, 1871, J. Pharm. Chim. 1898, **8**, 55, abst. Chem. Centr. 1889, **60**, II, 212, 1893, **64**, I, 535, 1898, **69**, II, 423, Jahr. Chem. 1898, **51**, 978.
- 11 Belg. P. 139356, 1898 See also Zts. Schiess. Spreng. 1912, **7**, 59; abst. C. A. 1912, **6**, 1227.
- 12 Belg. P. 146700, 1899
- 13 Belg. P. 140816, 1899; 153548, 1900, 161968, 1902
- 14 E. P. 17159, 1898; abst. J. S. C. I. 1898, **17**, 1178
- 15 E. P. 21878, 1897; abst. J. S. C. I. 1898, **17**, 61
- 16 Belg. P. 130172, 1897, 134987, 136612, 1898
- 17 Belg. P. 140349, 1899.
- 18 Belg. P. 140648, 1899.
- 19 Belg. P. 139066, 1898. Seventh Inter. Cong. Appl. Chem. 1909, VI-B, **77**; abst. J. S. C. I. 1911, **30**, 233.
- 20 Belg. P. 133898, 1898 See F. Coudert, U. S. P. 608652, 1898
- 21 E. P. 1208, 1898, abst. J. S. C. I. 1899, **18**, 126, 290
- 22 Belg. P. 159445, 1901.
- 23 Bull. Soc. Chim. 1903, **29**, 765, abst. J. S. C. I. 1903, **22**, 959.
- 24 Rev. Chim. 1904, **7**, 165, abst. J. S. C. I. 1904, **23**, 723. Seventh

F. Calmant,¹ L. Crismer,² S. Young,³ J. Weigl,⁴ A. Bannow,⁵
 E. Van den Hoff,⁶ Behrend,⁷ C. Bruyere,⁸ T. Tyrer,⁹ E. Billet,¹⁰
 H. Blackmore,¹¹ J. Meyer and J. Arbuckle,¹² G. Arachequesne,¹³
 T. Rosati,¹⁴ T. Aldrich,¹⁵ H. Rosalt,¹⁶ P. Magnier and P. Brangier,¹⁷
 M. Sunye,¹⁸ G. Pereire and G. Guignard,¹⁹ L. Philippe,²⁰ J. Petersen,²¹
 O. Saare,²² J. Savary,²³ O. Silberrad,²⁴ E. Siermann,²⁵ V. Slavicek,²⁶
 C. Šomlő,²⁷ Spink Liquor Co.,²⁸ S. Jay & Co.,²⁹ Soc. Verrieux pere et fils,³⁰
 Soc. Chim. Usines du Rhone,³¹ Soc. de Lille

Inter. Cong. Appl. Chem. 1909; abst. J. S. C. I. 1909, **28**, 736. Bull. Assoc. chim. Sucr. Dist. **30**, 600; abst. C. A. 1914, **8**, 2472.

25. Belg. P. 152925, 1900. E. P. 24229, 1906; abst. J. S. C. I. 1907, **26**, 427.

1. Belg. P. 147506, 1900; 165540, 1902; 168747, 1903; 183438, 1905.

2. Bull. Soc. chim. Belg. 1904, **18**, 128; abst. J. S. C. I. 1904, **23**, 877.

3. Proc. Chem. Soc. 1902, **18**, 104; abst. J. S. C. I. 1902, **21**, 721.

4. Arch. Hyg. **44**, 273; abst. Chem. Centr. 1902, **73**, II, 1070; J. S. C. I. 1902, **21**, 1466.

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7. Locomotion Automobile, Aug. 8, 1901, 503; Proc. Inst. Civil Eng 1902, **147**, 79; abst. J. S. C. I. 1902, **21**, 1019.

8. Belg. P. 174129, 1903.

9. J. S. C. I. 1903, **22**, 257.

10. Belg. P. 164598, 1902.

11. U. S. P. 774824, 1904; abst. Mon. Sci. 1905, **63**, 64; Chem. Zts. 1905, **4**, 40; Chem. Ztg. 1904, **28**, 1177; J. A. C. S. 1905, **27R**, 435.

12. E. P. 4218, 1903; abst. J. S. C. I. 1903, **22**, 567.

13. Bull. Assoc. des Chim. Sucr. Dist. 1901, **19**, 243; abst. J. S. C. I. 1902, **21**, 108. Ann. Brasserie, 1903, **6**, 387; abst. J. S. C. I. 1903, **22**, 1361.

14. Belg. P. 159113, 1901.

15. U. S. P. 761188, 761189, 1904; abst. Mon. Sci. 1904, **61**, 137; Chem. Ztg. 1904, **28**, 602; J. A. C. S. 1905, **27R**, 57. J. A. C. S. 1911, **33**, 386; abst. J. C. S. 1911, **100**, i, 346.

16. F. P. 346606, 1904; abst. J. S. C. I. 1905, **24**, 191; Mon. Sci. 1906, **65**, 99; Chem. Zts. 1905, **4**, 64; C. A. 1907, **1**, 340, 377.

17. U. S. P. 695573, 1902; E. P. 12241, 1899; abst. J. S. C. I. 1902, **21**, 632; 1900, **19**, 165.

18. F. P. 328143, 1904; abst. Mon. Sci. 1904, **61**, 170; Chem. Zts. 1903, **2**, 278.

19. F. P. 316062, 1901; abst. J. S. C. I. 1902, **21**, 558, 1090. D. R. P. 139387, 1901; abst. Chem. Ztg. 1903, **27**, 223; J. S. C. I. 1903, **22**, 432; Wag. Jahr. 1903, **49**, II, 400.

20. Belg. P. 154471, 1901.

21. Zts. physik. Chem. 1900, **33**, 99, 295, 698; abst. Jahr. Chem. 1900, **53**, 621.

22. Zts. Spiritusind. 1902, 68; abst. Wag. Jahr. 1902, **48**, II, 457.

23. Belg. P. 159538, 1901.

24. J. S. C. I. 1902, **21**, 827.

25. Chem. Ztg. 1901, **25**, 1158; abst. J. S. C. I. 1902, **21**, 164.

26. Belg. P. 167884, 1903.

27. Belg. P. 179071, 1903.

28. Belg. P. 149893, 1900.

29. F. P. 321863.

30. F. P. 332620, 1903; abst. J. S. C. I. 1903, **22**, 1253; Mon. Sci. 1904,

et Bonnieres,¹ J. Effront,² J. Jean & Co. and G. Raverat,³ International Spiritus Industrie Gesellschaft m. b. H.,⁴ M. Guérbet,⁵ S. Grawitz,⁶ E. Guillaume,⁷ G. Denigès,⁸ L. Denayrouze,⁹ N. Dromain,¹⁰ G. Hache,¹¹ L. Haigh,¹² G. Halphen,¹³ Pampe and Trolle,¹⁴ A. Mentior,¹⁵ C. Mettler,¹⁶ W. Noyes and R. Warfel,¹⁷ R. Junge,¹⁸ A. Leoni, A. Pelizza and E. Stringa,¹⁹ L. Lindet,²⁰ H. Kratz-Bous-sac,²¹ R. Hirsch,²² Hiller-Bombin,²³ L. Highton,²⁴ G. Heinzelmann,²⁵ T. Heidlberg,²⁶ A. Frank-Kamentzky,²⁷ J. Waterkeyn,²⁸ Cie Industr.

61, 170.

31. E. P. 14699, 1902; abst. J. S. C. I. **19** 1903, **22**, 880. E. P. 122630, 1919; abst. J. S. C. I. 1919, **38**, 739-A.

1. F. P. 324778, 1902.

2. Belg. P. 165182, 1902; 173651, 1903.

3. F. P. 345138, 1904; abst. J. S. C. I. 1904, **23**, 1231, Chem. Zts. 1905, **4**, 257.

4. Belg. P. 177128, 1904.

5. Bull. Soc. Chim. 1902, **27**, 578, 581, 584; abst. J. S. C. I. 1902, **21**, 984; Jahr. Chem. 1902, **55**, 777. See also Jahr. Chem. 1901, **54**, 615.

6. Belg. P. 159893, 1901.

7. Belg. P. 149034, 1900; 161881, 1902; 199053, 1907.

8. Bull. soc. pharm. Bordeaux, 1910, **27**, 306; abst. J. S. C. I. 1910, **19**, 1036.

9. Pharm. J. 1902, **69**, 295; abst. J. S. C. I. 1902, **21**, 1268.

10. Belg. P. 165400, 1902.

11. Belg. P. 167802, 1903. F. P. 320592, 1902; additions dated April 22, 1902; Sept. 10, 1902; abst. J. S. C. I. 1903, **22**, 108, 431, 567. F. P. 328420, 1903; abst. J. S. C. I. 1903, **22**, 960. Neuste Erfahr. Erfind. 1904, **31**, 76.

12. Pharm. Rev. 1903, **21**, 404; abst. Chem. Ztg. Rep. 1903, **27**, 300; J. S. C. I. 1903, **22**, 1370.

13. J. pharm. chim. 1900, **11**, 373; abst. J. S. C. I. 1900, **19**, 472; Jahr. Chem. 1900, **53**, 946.

14. F. P. 317903, 1902; abst. J. S. C. I. 1902, **21**, 1389. F. P. 318232, 1902; abst. J. S. C. I. 1902, **21**, 1447.

15. Belg. P. 157589, 1901.

16. F. P. 348951, 1904; abst. J. S. C. I. 1905, **24**, 559. U. S. P. 815548; abst. Mon. Sci. 1908, **69**, 52; J. A. C. S. 1906, **28R**, 473. E. P. 14316, 1905; abst. J. S. C. I. 1905, **24**, 1125.

17. J. A. C. S. 1901, **23**, 463; abst. J. S. C. I. 1901, **20**, 928.

18. Belg. P. 173677, 1903.

19. F. P. 341617, 1904; abst. J. S. C. I. 1904, **23**, 878; Mon. Sci. 1906, **65**, 5.

20. Bull. assoc. chim. suc. dist. 1904, **22**, 459; abst. J. S. C. I. 1905, **24**, 146.

21. Belg. P. 170403, 1903.

22. Chem. Ind. 1900, **23**, 511; abst. J. S. C. I. 1901, **20**, 134.

23. Russian Patent, abst. Zts. Spiritusind. 1902, **25**, 453; J. S. C. I. 1902, **21**, 1343.

24. Belg. P. 171550, 1903. U. S. P. 736098, 1903; abst. J. A. C. S. 1906, **26R**, 188; Mon. Sci. 1903, **59**, 185.

25. Zts. Spiritusind. 1904, **27**, 399; abst. J. S. C. I. 1904, **23**, 995; Wag. Jahr. 1904, **50**, II, 376.

26. F. P. 346152, 1904; 378988, 1907; abst. J. S. C. I. 1905, **24**, 101; 1907, **26**, 1211.

27. Chem. Ztg. 1908, **32**, 569; abst. Chem. Zentr. 1908, **79**, II, 262;

- des Alcools de l'Ardeche,¹ A. Cox,² A. Bogajawlskij and V. Humnicki,³ A. Woolner, and A. Lassloff,⁴ F. Bowly,⁵ R. Vallat,⁶ E. Vloeberghs,⁷ L. Van Ryn,⁸ E. Blondel,⁹ Boulanger,¹⁰ G. Rubbens,¹¹ P. Askenasy, R. Leiser and N. Grünstein,¹² V. Auger,¹³ J. Pozzi-Escot,¹⁴ B. Plehm,¹⁵ W. Plücker,¹⁶ G. Imbert and W. Krafft,¹⁷ E. Gottlieb,¹⁸ J. Fleischer and H. Frank,¹⁹ L. Dautrebande,²⁰ A. Doroshowski and A. Rakowski,²¹ F. Dunlap,²² R. Duchemin and J. Dourlen,²³ A. Durupt,²⁴ L. Clarke,²⁵ L. Winkler,²⁶
- J. S. C. I. 1908, **27**, 702
28. E. P. 348, 1908, abst. J. S. C. I. 1908, **27**, 1218
 1. E. P. 404360, 1908, E. P. 18028, 1909, abst. J. S. C. I. 1910, **29**, 211, 646; Swiss P. 53961, 1910
 2. Philippine J. Sci. 1909, **4A**, 232, abst. C. A. 1909, **3**, 2868; J. S. C. I. 1909, **28**, 1057.
 3. Zts. ang. Chem. 1908, **21**, 1639, abst. Chem. Zentr. 1908, **79**, II, 1137; J. S. C. I. 1908, **27**, 871
 4. U. S. P. 923232, 1909, abst. J. S. C. I. 1909, **28**, 737; C. A. 1909, **3**, 2198
 5. U. S. P. 866426, 1907, abst. J. S. C. I. 1907, **26**, 1253; Chem. Ztg. Ref. 1907, **31**, 625.
 6. Belg. P. 193694, 194612, 209896, 1906
 7. Belg. P. 190357, 1906
 8. Belg. P. 184856, 1905
 9. Zts. Spiritusind. 1908, **31**, 225, abst. C. A. 1908, **2**, 693, 1468; J. S. C. I. 1908, **27**, 585
 10. Zts. Spiritusind. 1908, **31**, 225, abst. J. S. C. I. 1908, **27**, 585.
 11. Belg. P. 212498, 1908
 12. Zts. Elektrochem. 1909, **15**, 816; abst. J. S. C. I. 1909, **28**, 1266; C. A. 1910, **4**, 279
 13. Compt. rend. 1906, **143**, 907, abst. Chem. Zentr. 1907, **78**, I, 400; C. A. 1907, **1**, 556
 14. Bull. assoc. chim. suc. dist. **26**, 580, abst. Chem. Zentr. 1909, **80**, I, 1229; C. A. 1909, **3**, 1199
 15. F. P. 345777, 1904, abst. J. S. C. I. 1905, **24**, 80; Mon. Sci. 1906, **65**, 98.
 16. Zts. Nahr. Genussm. 1909, **17**, 454; abst. Chem. Zentr. 1909, **80**, I, 1973; C. A. 1909, **3**, 2032.
 17. D. R. P. 164297; abst. Chem. Zentr. 1905, **76**, II, 1747; Wag. Jahr. 1905, **51**, II, 5.
 18. Belg. P. 212043, 1908
 19. Chem. Ztg. 1907, **31**, 665, abst. Chem. Zentr. 1907, **78**, II, 743; J. S. C. I. 1907, **26**, 838
 20. Belg. P. 191380, 1906
 21. J. Russ. Phys. Chem. Soc. 1908, **40**, 860, abst. Chem. Zentr. 1908, **79**, II, 1568; J. S. C. I. 1909, **28**, 101; Jahr. Chem. 1909, **62**, II, 101; J. C. S. 1909, **96**, ii, 968; Bull. Soc. Chim. 1909, **6**, 102.
 22. J. A. C. S. 1906, **28**, 395, abst. J. S. C. I. 1906, **25**, 390; Chem. Centr. 1906, **77**, I, 1692.
 23. Compt. rend. 1905, **140**, 1466, abst. J. S. C. I. 1905, **24**, 684; Jahr. Chem. 1905-1908, **61**, 184.
 24. F. P. 368713, 1906, and addition thereto dated Aug. 27, 1908; E. P. 17841, 1907; abst. C. A. 1909, **3**, 229; J. S. C. I. 1907, **26**, 29, 1217; 1908, **27**, 994. Belg. P. 201786, 1907.
 25. Amer. Chem. J. 1908, **39**, 87; abst. Jahr. Chem. 1905-1908, II,

N. Whitehouse and N. Beetlestone,¹ S. Fabbri,² N. Mauger,³ A. Mabile,⁴ O. Mohr,⁵ P. Mouquet,⁶ J. Novel,⁷ W. Löb,⁸ A. Lecomte,⁹ T. Körner,¹⁰ J. Kluge,¹¹ W. Kiby,¹² M. Halaubek,¹³ E. Hager,¹⁴ A. Haack,¹⁵ M. Pichard,¹⁶ V. Perelzveich and G. Rosenbusch,¹⁷ G. Prochazka,¹⁸ R. Duchemin,¹⁹ Santolyne,²⁰ J. Senderens,²¹ J. Schroeder,²² D. Sidersky,²³ W. Solomon,²⁴ C. Steffen,²⁵ H. Steyls,²⁶ F.

83, *Chem. Zentr.* 1908, **79**, I, 808, *Bull. Soc. Chim.* 1909, **6**, 284.

26. *Ber.* 1905, **38**, 3612, abst. *J. S. C. I.* 1905, **24**, 1253; *Jahr. Chem.* 1905-1908, II, 179.

1. E. P. 4274, 1906, abst. *C. A.* 1907, **1**, 841, 927, *J. S. C. I.* 1907, **26**, 113.

2. E. P. 27713, 1909, abst. *J. S. C. I.* 1910, **29**, 1325, *C. A.* 1911, **5**, 2804.

3. E. P. 23806, 1908, abst. *J. S. C. I.* 1909, **28**, 237, *C. A.* 1909, **3**, 2220.

4. F. P. 378518, 1907, and addition thereto dated Nov. 8, 1907; abst. *J. S. C. I.* 1907, **26**, 1131, 1908, **27**, 437.

5. Seventh Inter. Cong. Appl. Chem. 1909, abst. *J. S. C. I.* 1909, **28**, 692, *Zts. ang. Chem.* 1914, **27**, 558; abst. *J. S. C. I.* 1915, **34**, 18.

6. F. P. 385136, 1907, abst. *J. S. C. I.* 1908, **27**, 586.

7. F. P. 380310, 1907, and addition dated July 25, 1908, abst. *C. I.* 1908, **27**, 14, 1909, **28**, 16.

8. *Biochem. Zts.* 1909, **20**, 126, abst. *J. S. C. I.* 1909, **28**, 1005, *Chem. Zentr.* 1909, **80**, II, 971.

9. *Bull. assoc. chim. suc. dist.* 1905, **23**, 386, abst. *J. S. C. I.* 1905, **24**, 1248; *Jahr. Chem.* 1905-1908, II, 184.

10. *Zts. ang. Chem.* 1908, **21**, 2553, abst. *J. C. S.* 1908, **94**, i, 955, *C. A.* 1909, **3**, 484; *J. S. C. I.* 1908, **27**, 1217.

11. E. P. 16153, 1911; F. P. 432605, 1911, *Belg. P.* 237351, 1911; abst. *C. A.* 1913, **7**, 206; *J. S. C. I.* 1912, **31**, 88, 147. E. P. 19257, 1909, abst. *J. S. C. I.* 1910, **29**, 170. D. R. P. 239530, 1910, abst. *C. A.* 1912, **6**, 2134.

12. *Chem. Ztg.* 1910, **34**, 1077, 1091, abst. *J. S. C. I.* 1910, **29**, 1265; *C. A.* 1911, **5**, 785.

13. *Belg. P.* 184008, 1905.

14. F. P. 395971, 1908, abst. *Mon. Sci.* 1909, **71**, 147, *C. A.* 1910, **4**, 79.

15. E. P. 5790, 1909, abst. *J. S. C. I.* 1909, **28**, 1218, *C. A.* 1910, **4**, 1345.

16. *Belg. P.* 183841, 1905.

17. U. S. P. 919759, 1909; E. P. 26915, 1907; F. P. 397092, 1908, abst. *J. S. C. I.* 1908, **27**, 826; 1909, **28**, 693; 1912, **31**, 514, *C. A.* 1909, **3**, 580, 1803; 1910, **4**, 3121; *Drug. Circ.* 1912, **54**, 199. See also U. S. P. 993446, 1911.

18. *J. S. C. I.* 1909, **28**, 696, abst. *C. A.* 1910, **3**, 1381.

19. *Bull. assoc. chim. suc. dist.* **26**, 1076; abst. *Chem. Zentr.* 1909, **80**, II, 1021; *Jahr. Chem.* 1909, **62**, II, 102, *J. C. S.* 1909, **96**, i, 450.

20. *Cosmos*, 1908, **58**, 519. See also A. Boidm, *Swiss P.* 53952, 1910.

21. *Compt. rend.* 1907, **144**, 1109, abst. *Chem. Zentr.* 1907, **78**, II, 289; *C. A.* 1907, **1**, 2231.

22. *J. Russ. Phys. Chem. Soc.* 1908, **40**, 360, abst. *Chem. Zentr.* 1908, **79**, II, 479; *C. A.* 1909, **3**, 884.

23. *Bull. assoc. chim. suc. dist.* 1905, **23**, 545; abst. *J. S. C. I.* 1906, **25**, 35.

24. U. S. P. 885095, 885096, 1908; abst. *J. S. C. I.* 1908, **27**, 495; *Mon. Sci.* 1908, **63**, 118.

25. *Belg. P.* 193356, 1906; 225128, 1910; D. R. P. 223966, 1909; abst. *C. A.* 1910, **4**, 3119.

26. *Belg. P.* 190677, 1906.

Stewart,¹ Stora Kopparbergs Bergslas Aktiebolag,² Soc. Anon. des Plaques et Papiers Photographiques A. Lumiere et ses Fils,³ F. Ehrlich,⁴ Elektrochemische Werke G. m. b. H.,⁵ G. Ekström and Aktiebolaget Ethyl,⁶ W. Junker and F. Degener,⁷ M. Jouas, M. Desmots, L. Deglatigny and L. Dubosc,⁸ and E. Kayser and A. Demolon.⁹

From 1910 until the commencement of the war, interest was obviously unabated in endeavors to open new fields of usefulness for the solvent properties of ethyl alcohol, the advancement being reflected in the contributions on the subject as published by A. Collens,¹⁰ Chem. Fabrik Griesheim-Elektron,¹¹ A. Zeckendörf and Maschinenbau Aktiengesell. Golzern-Grimma,¹² H. Cornette and L. Faucheux,¹³ F. Baker,¹⁴ J. Wade and R. Merriman,¹⁵ H. Verlinden,¹⁶

1. U. S. P. 923088, 1909, abst. J. S. C. I. 1909, **28**, 737; C. A. 1909, **3**, 2032.
2. Belg. P. 219362, 1909. F. P. 402331, 1909, abst. J. S. C. I. 1909, **28**, 1221. Norw. P. 22041, 1909; abst. Chem. Ztg. 1912, **36**, 618.
3. F. P. 361324, 1905; abst. Mon. Sci. 1906, **65**, 169; 1907, **66**, 599; C. A. 1907, **1**, 962, 1082.
4. Belg. P. 188787, 1905. See Zts. Ver. Zuckerind. 1915, **65**, 70; abst. C. A. 1915, **9**, 1824.
5. F. P. 21567, 1906; abst. J. S. C. I. 1906, **25**, 1231; Chem. Ztg. Rep. 1908, **32**, 130. F. P. 370093, abst. J. S. C. I. 1907, **26**, 223; Chem. Zts. 1907, **6**, 129; Mon. Sci. 1909, **71**, 27. Belg. P. 194784, 1906. D. R. P. 175780, 1905; abst. Chem. Centr. 1906, **77**, II, 1666; Chem. Zts. 1907, **6**, 270; Jahr. Chem. 1905-1908, II, 181; Chem. Ind. 1906, **29**, 574.
6. U. S. P. 1046160, 1050723; E. P. 18341, 1907; F. P. 421044, 1910; D. R. P. 207354, 1907; Hung. P. Appl. E-1952/53; abst. C. A. 1909, **3**, 2070; 1913, **7**, 677, 889, 1914, **8**, 2251; J. S. C. I. 1908, **27**, 514; 1914, **33**, 658; Mon. Sci. 1913, **79**, 111; Chem. Zentr. 1909, **80**, I, 1296; Chem. Ztg. Rep. 1913, **37**, II, 200, 244; Wag. Jahr. 1909, **55**, II, 228. See also Papierfabr. 1910, **8**, 582; abst. J. S. C. I. 1910, **29**, 810. Norw. P. 23511, 1912. Swed. P. 34623, 34624. See P. Ekstrom, U. S. P. 1095830, 1914.
7. F. P. 360715, 1905; abst. C. A. 1907, **1**, 1610, 1648; Mon. Sci. 1907, **67**, 46.
8. F. P. 360180, 1905; abst. Mon. Sci. 1906, **65**, 141; J. S. C. I. 1906, **25**, 495.
9. Compt. rend. 1908, **146**, 783; abst. J. S. C. I. 1908, **27**, 463; Chem. Zentr. 1908, **79**, I, 1941.
10. Bull. Dept. Agric. Trinidad and Tobago, 1914, **14**, 56; abst. J. S. C. I. 1915, **34**, 629; C. A. 1915, **9**, 2284.
11. D. R. P. 236591, 1909, abst. C. A. 1911, **5**, 3608; Zts. ang. Chem. 1911, **24**, 1549; Chem. Zentr. 1911, **82**, II, 313.
12. F. P. 434949, 1911; abst. J. S. C. I. 1912, **31**, 354. Belg. P. 239281, 1911; U. S. P. 1051051; abst. Chem. Ztg. 1913, **37**, 244.
13. F. P. 437014; abst. J. S. C. I. 1912, **31**, 405. Belg. P. 243653, 1912.
14. J. C. S. 1912, **101**, 1411; abst. C. A. 1912, **6**, 3402; Chem. Zentr. 1912, **83**, II, 1527.
15. J. C. S. 1912, **101**, 2432; abst. C. A. 1913, **7**, 1314; J. S. C. I. 1913, **32**, 108.
16. Belg. P. 228627, 1910; 245679, 1912. F. P. 433323, 1912.

T. Bolas,¹ M. Barätöff,² F. Thatcher and L. Stiles,³ E. Rinman,⁴ L. Rivieffe,⁵ A. de Posnansky,⁶ P. Marin,⁷ A. Hirsch,⁸ J. Parnas,⁹ C. Schwalbe,¹⁰ C. Schiller,¹¹ L. Spassky,¹² Standard Alcohol Co.,¹³ O. Stern,¹⁴ E. de Stoecklin,¹⁵ P. Szeberenyi,¹⁶ Soc. E. Barbet et Fils et Cie.,¹⁷ A. Joseph and W. Rae,¹⁸ E. Gazagne and R. de Muth,¹⁹ E. Gazagne and M. Pingris,²⁰ H. Gasser,²¹ M. Fulton,²² F. Freyer and H. Mueller,²³ G. Foth,²⁴ R. de Fazi,²⁵ R. von Dornuth,²⁶ C. Dill,²⁷

1. J. Roy. Soc. Arts, 1914, **62**, 863, abst. J. S. C. I. 1914, **33**, 935
2. Belg. P. 262543, 1913.
3. Australian P. 12891, 1914, U. S. P. 1006965, 1914, F. P. 6775, 1914; abst. C. A. 1914, **8**, 2448, J. S. C. I. 1914, **33**, 659, 979
4. D. R. P. 270929, 1911; abst. C. A. 1914, **8**, 2482. See also C. A. 1912, **6**, 3183. F. P. 6652, 1912, abst. J. S. C. I. 1913, **32**, 284, C. A. 1913, **7**, 3025. F. P. 441186, abst. J. S. C. I. 1912, **30**, 812.
5. Belg. P. 232551, 234753, 1911, First Addition, July 1, 1914, to F. P. 475938, 1914, abst. J. S. C. I. 1916, **35**, 1102. See also F. P. 374179, abst. J. S. C. I. 1907, **26**, 769, 1909, **28**, 317.
6. Belg. P. 249158, 1912, F. P. 464502, 468188, 1913, abst. C. A. 1914, **8**, 3215, J. S. C. I. 1914, **33**, 978. Span. P. 55488, abst. Chem. Ztg. 1913, **37**, 1009. A. de Posnansky and L. Spassky, F. P. 459593, 1912, Ital. P. 128003; abst. Chem. Ztg. 1913, **37**, 968, 1292.
7. F. P. 467838, 1914, abst. C. A. 1915, **9**, 2124, Chem. Ztg. Rep. 1915, **39**, 86.
8. J. Ind. Eng. Chem. 1912, **4**, 478, abst. C. A. 1902, **6**, 2281.
9. Biochem. Zts. 1910, **28**, 274, abst. Chem. Zentr. 1910, **81**, II, 1668, C. A. 1911, **5**, 524.
10. Zts. ang. Chem. 1910, **23**, 1537, abst. Chem. Zentr. 1910, **81**, II, 1101, J. S. C. I. 1910, **29**, 1052.
11. E. P. 16474, 1914, abst. J. S. C. I. 1915, **34**, 1160.
12. Belg. P. 243033, 1912, F. P. 451268, abst. C. A. 1913, **7**, 3187, Mon. Sci. 1914, **81**, 42. Span. P. 52308, 1912, abst. Chem. Ztg. 1912, **36**, 751.
13. F. P. 460084, 460086, 1913, abst. C. A. 1914, **8**, 3215. Ital. P. 130925, 1913, abst. Chem. Ztg. 1913, **37**, 1433.
14. Zts. physik. Chem. 1912, **81**, 441, abst. C. A. 1913, **7**, 2714.
15. Compt. rend. 1910, **150**, 13, abst. J. S. C. I. 1908, **27**, 173, C. A. 1910, **4**, 886.
16. Chem. Ztg. 1913, **37**, 757, abst. Chem. Zentr. 1913, **84**, II, 541; C. A. 1913, **7**, 3639.
17. E. P. 121797, 1914, abst. C. A. 1919, **13**, 886, J. S. C. I. 1919, **38**, 115-A.
18. J. S. C. I. 1913, **32**, 856, 1914, **33**, 991, abst. C. A. 1913, **7**, 3818; 1915, **9**, 235.
19. F. P. 477077, 1914, abst. J. S. C. I. 1916, **35**, 613, Ann. Rep. Soc. Chem. Ind. 1917, **2**, 145.
20. Belg. P. 248306, 1912.
21. Belg. P. 239097, 1911.
22. U. S. P. 993446, 1911, abst. C. A. 1911, **5**, 2548.
23. Arch. Chem. Mikros. **6**, 77; abst. C. A. 1913, **7**, 2648.
24. Zts. Spiritusind. 1913, **36**, 497, Chem. Ztg. 1913, **37**, 1221; abst. C. A. 1914, **8**, 241.
25. E. P. 1335, 1914; abst. C. A. 1915, **9**, 1825; J. S. C. I. 1914, **33**, 936.
26. Zts. ang. Chem. 1913, **26**, 786; abst. C. A. 1914, **8**, 1343, J. S. C. I. 1914, **33**, 71.
27. F. P. 477812, 1914; abst. C. A. 1916, **10**, 1407; Mon. Sci. 1917, **84**, 45.

C. Doby,¹ A. Doroszewski,² J. Gilpin,³ N. Olie,⁴ H. Oldekop,⁵ O. Overbeck,⁶ Champy Freres,⁷ S. Vance,⁸ Soc. Française des Distilleries de l'Indo Chine,⁹ B. Smärt,¹⁰ C. Schilling,¹¹ O. Pfeiffer,¹² J. Kluge,¹³ and F. Santo-Canale.¹⁴

From 1915 to the present time (1920) much activity has been shown in the question of the suitable denaturation of alcohol to diminish its potability so that an increase in the arts is possible without the payment of Government revenue, and many formulas for this purpose have been suggested and officially approved, looking to the denaturation of ethyl alcohol for specific arts. In addition, the researches along lines of solvent utilization, especially as a constituent as such or after esterification in cellulose ester fluid preparations, and in the celluloid thermoplastic combinations, are covered by the disclosures of S. Morgenstern,¹⁵ V. Martinand,¹⁶ J. Mayrhofer,¹⁷ Maschinenbau-Akt. Ges. Golzern-Grimma,¹⁸ T. Norton,¹⁹ Lewy,²⁰ A. Lebbe,²¹ Lindenmeyer & Co.,²² R. Lespian,²³ B. Lacy,²⁴ A. Langgaard,²⁵ A. Kuester,²⁶ K.

1. Chem. Ztg. 1910, **34**, 1330, abst. Deut. Zuckerind. 1910, **35**, 1017; C. A. 1911, **5**, 1000. E. Simonsen, Norw. P. 23679, 1912.
2. J. Russ. Phys. Chem. Soc. 1900, **41**, 958; abst. Chem. Zentr. 1910, **82**, I, 156.
3. Amer. Chem. J. 1910, **43**, 466, abst. C. A. 1910, **4**, 2372.
4. Mem. Poud. Salpêtres, 1910, **15**, 160; abst. J. S. C. I. 1911, **30**, 200.
5. Zts. Nahr. Genussm. 1913, **26**, 129, abst. C. A. 1913, **7**, 4040. See also A. Verley and F. Bolsing, Ber. 1901, **34**, 3354.
6. E. P. 4177, 1910; abst. J. S. C. I. 1910, **29**, 1127. E. P. 5170, 1911.
7. Belg. P. 225873, 1910.
8. U. S. P. 760939, 1904; abst. Mon. Sci. 1905, **63**, 80.
9. F. P. 459634, 459815, 1912; abst. C. A. 1914, **8**, 3215.
10. Swed. P. 31956, 1909; Norw. P. 22263, 1910; abst. Chem. Ztg. 1912, **36**, 367, 786.
11. D. R. P. Anm. 41406, 1912, F. P. 459947, 1913; abst. Chem. Ztg. Rep. 1914, **38**, 460.
12. D. R. P. 243067, 1910; abst. Wag. Jahr. 1912, **58**, II, 420.
13. D. R. P. 246568, addition to D. R. P. 239530; abst. Chem. Zentr. 1911, **82**, II, 1391; 1912, **83**, I, 1870. F. P. 432605, 1911.
14. Ital. P. 114098, 1910; abst. Chem. Ztg. 1912, **36**, 425.
15. U. S. P. 991874; E. P. 22605, 1910; F. P. 421044; abst. J. S. C. I. 1911, **30**, 435, 649.
16. Belg. P. 251266, 1912.
17. Arch. Chem. Mikros. **4**, 183; abst. C. A. 1911, **5**, 3551.
18. E. P. 22411, 1911; D. R. P. 255300; abst. J. S. C. I. 1912, **31**, 947.
19. U. S. Cons. Reports, Nov. 1911; abst. J. S. C. I. 1911, **30**, 1466; C. A. 1912, **6**, 1524.
20. F. P. 318129, 1902; abst. J. S. C. I. 1902, **21**, 1448; Mon. Sci. 1903, **59**, 191.
21. Belg. P. 235767, 1911.
22. Belg. P. 226119, 1910.
23. Ann. Chim. Phys. 1912, **27**, 170; abst. J. C. S. 1912, **102**, i, 934;

- Kubierschky,¹ G. Kraemer,² F. Körber,³ K. Kopitsch,⁴ Konsortium für Elektrochemische Industrie G. m. b. H.,⁵ Gebf. Korting Akt. Ges.,⁶ F. Klein,⁷ E. Bertini,⁸ Horbaczewski,⁹ E. von Lippman,¹⁰ G. Yeoman,¹¹ C. Davin and M. Harvey,¹² R. Denington,¹³ P. Desmarais,¹⁴ H. Dreyfus,¹⁵ J. Doubleday,¹⁶ E. I. duPont de Nemours and Co.,¹⁷ A. Dubosc,¹⁸ E. Chenard,¹⁹ S. Cettolini,²⁰ W. Crawford,²¹ G. Tomlinson,²² Cie des Produits Chimiques d'Alais et de la Camargue,²³ O. Willcox,²⁴ C. West,²⁵ J. Schneible,²⁶ H. C. A. 1913, **7**, 1496.
24. U. S. P. 1253055, 1918, Can. P. 491542, 1919, abst. C. A. 1919, **13**, 1861; E. P. 205550, 1914, abst. C. A. 1916, **10**, 953.
 25. Berl. Klm. Wochschr. 1913, **49**, 1704, abst. C. A. 1913, **7**, 2433, J. C. S. 1913, **104**, i, 141.
 26. Belg. P. 239187, 1911.
 1. D. R. P. 287897, 1914, abst. J. S. C. I. 1916, **35**, 377, Wag. Jahr 1915, **61**, II, 244; Chem. Zentr. 1915, **86**, II, 1032, Chem. Abg. Rep. 1916, **40**, 49, Zts. ang. Chem. 1915, **28**, II, 637.
 2. Zts. Spiritusind. 1912, **35**, 417, abst. J. S. C. I. 1912, **31**, 700, C. A. 1912, **6**, 3490.
 3. Wied. Ann. Phys. 1912, **37**, 1021, abst. J. C. S. 1912, **102**, ii, 538, C. A. 1913, **7**, 1999.
 4. Aust. 44104, 57875, 57878, abst. Chem. Ztg. 1913, **37**, 244.
 5. Belg. P. 262208, abst. Kunst. 1914, **4**, 379.
 6. Belg. P. 246732, 1912.
 7. J. Ind. Eng. Chem. 1910, **2**, 389, abst. J. S. C. I. 1910, **29**, 222, C. A. 1910, **4**, 3053.
 8. E. P. 2137, 1912; abst. J. S. C. I. 1912, **31**, 864, C. A. 1913, **7**, 2464.
 9. Oest. Chem. Ztg. **14**, 139, abst. J. S. C. I. 1911, **30**, 826, C. A. 1911, **5**, 3906.
 10. Zts. ang. Chem. 1912, **25**, 1680, abst. C. A. 1912, **6**, 3157; Chem. Ztg. 1912, **36**, 2061; 1913, **37**, 1316, 1346, 1358, 1419, 1428, 1917, **41**, 865, 883, 909, abst. C. A. 1913, **7**, 205, 548, 1918, **12**, 2147, J. C. S. 1913, **104**, i, 298; 1918, **114**, i, 210.
 11. U. S. P. 983854; abst. C. A. 1911, **5**, 1472.
 12. J. Ind. Eng. Chem. 1919, **11**, 443, abst. J. S. C. I. 1919, **38**, 434-A; C. A. 1919, **13**, 1411.
 13. Chem. Trade J. 1918, **63**, 145, abst. Chem. Zentr. 1919, **90**, II, 183.
 14. F. P. 481037, 481038, 1916, abst. C. A. 1917, **11**, 2959.
 15. E. P. 108856, 1917; abst. C. A. 1918, **12**, 154.
 16. U. S. P. 1306087, 1919, abst. C. A. 1919, **13**, 2157, J. S. C. I. 1919, **38**, 563-A.
 17. E. P. 119249, 1917, abst. J. S. C. I. 1918, **37**, 717-A.
 18. Caout. et Gutta-p. 1918, **15**, 9542, abst. C. A. 1919, **13**, 450.
 19. U. S. P. 1307184, 1919, abst. C. A. 1919, **13**, 2156.
 20. Boll. ist. int. agric. **6**, 16, Ind. Chim. min. met. 1915, **2**, 80, abst. C. A. 1915, **9**, 2284.
 21. E. P. 112166, 1916; abst. C. A. 1918, **12**, 1050; J. S. C. I. 1918, **37**, 107-A.
 22. Can. Hon. Adv. Council for Sci. Ind. Res. Bull. 1919, **7**, 9; abst. C. A. 1920, **14**, 89. J. Ind. Eng. Chem. 1918, **10**, 859; Chem. Met. Eng. 1918, **19**, 552; abst. C. A. 1918, **12**, 2437.
 23. E. P. 128929, 1919; abst. C. A. 1919, **13**, 2383; J. S. C. I. 1919, **38**, 486-A.
 24. U. S. P. 1312293; abst. C. A. 1919, **13**, 2595; J. S. C. I. 1919, **38**, 715-A.

Cox,¹ C. Baskerville,² A. Breckler,³ L. Wolfrum and J. Pinnow,⁴ F. Babington and A. Tingle,⁵ Verwertung Inländischer Produkte G. m. b. H.,⁶ Boucher,⁷ H. Boulard,⁸ A. Truelle,⁹ Elektrizitätswerk Lonza,¹⁰ W. Toplis,¹¹ O. Beyer,¹² F. Richard,¹³ Ruttan,¹⁴ A. Adams,¹⁵ The Acme Laboratories,¹⁶ E. Rideal,¹⁷ J. Reilly,¹⁸ Redwood and Boverton,¹⁹ W. Rae and C. Symons,²⁰ K. Hoepner,²¹ T. Heriot,²² W. Hempel,²³ E. Pantanelli,²⁴ P. Pascal,²⁵ K. Peche,²⁶ T.

25. Paper 1919, **25**, No. 13, 19, 23, abst. C. A. 1920, **14**, 308.
26. U. S. P. 1311251, 1311421, 1919, E. P. Appl. 18041, 1918; abst. J. S. C. I. 1919, **38**, 560-A, 603-A; Can. P. 196094, 1920.
1. Analyst, 1919, **44**, 26, abst. J. S. C. I. 1919, **38**, 117-A; C. A. 1919, **13**, 691.
2. U. S. P. 1208265, 1916, abst. J. S. C. I. 1917, **11**, 297; J. S. C. I. 1917, **36**, 70.
3. J. Ind. Eng. Chem. 1917, **9**, 612, abst. C. A. 1917, **11**, 2257, J. S. C. I. 1917, **36**, 902.
4. Zts. Nahr. Genuss. 1918, **35**, 270, abst. J. S. C. I. 1919, **38**, 383-A; C. A. 1919, **13**, 3269.
5. J. Ind. Eng. Chem. 1919, **11**, 555, abst. C. A. 1919, **13**, 1989, J. S. C. I. 1919, **38**, 509-A.
6. D. R. P. 311217, 1916, abst. J. S. C. I. 1919, **38**, 510-A; Chem. Zentr. 1919, **90**, II, 507.
7. Bull. ser. pharmacol. 1918, **25**, Pt. 295, abst. C. A. 1919, **13**, 497, Chem. Zentr. 1919, **90**, II, 219.
8. U. S. P. 1266657, 1918, E. P. 102945, 1916, abst. J. S. C. I. 1918, **37**, 525-A, 601-A; Can. P. 175000.
9. Compt. rend. séances acad. agr. 1917, **3**, 913, abst. C. A. 1918, **12**, 1585.
10. E. P. 120163, 1918, abst. J. S. C. I. 1919, **38**, 28-A; Swiss P. 74129, 77471, 1918, abst. C. A. 1917, **11**, 1884, 1918, **12**, 2326, Kunst. 1917, **7**, 141; 1919, **9**, 9. E. P. 134521, abst. J. S. C. I. 1920, **39**, 135-A; C. A. 1920, **14**, 746.
11. Amer. J. Pharm. 1918, **90**, 636; abst. J. S. C. I. 1918, **37**, 711-A; C. A. 1918, **12**, 2297.
12. Schweiz. Chem. Ztg. 1918, **2**, 12, abst. J. S. C. I. 1918, **37**, 193-A; C. A. 1918, **12**, 1878.
13. J. pharm. chim. 1914, **10**, 429, abst. C. A. 1915, **9**, 1224, J. S. C. I. 1915, **34**, 101.
14. Can. Chem. J. 1918, **2**, 211, abst. C. A. 1918, **12**, 2053.
15. J. Amer. Pharm. Assoc. 1919, **8**, 108, abst. C. A. 1919, **13**, 1615.
16. Can. P. 185743, 1918, abst. C. A. 1919, **13**, 161.
17. Chem. Age, 1919, **1**, 9, abst. J. S. C. I. 1919, **38**, 907-A; C. A. 1919, **13**, 3184.
18. Lecture delivered before the Royal Dublin Society, Feb. 19, 1919.
19. Chem. Age, 1919, **1**, 66.
20. E. P. 129904, 1918, abst. C. A. 1919, **13**, 2883.
21. Zts. Nahr. Genuss. 1917, **34**, 453, abst. J. S. C. I. 1919, **38**, 735-A.
22. J. S. C. I. 1915, **34**, 336, abst. C. A. 1915, **9**, 1825.
23. Zts. ang. Chem. 1914, **27**, 521; abst. J. S. C. I. 1915, **34**, 18; C. A. 1915, **9**, 372.
24. Staz. sper. agrar. ital. 1918, **51**, 85; abst. C. A. 1919, **13**, 2411.
25. E. P. 140115, 140527, 1919; abst. J. S. C. I. 1920, **39**, 385-A, 474-A.
26. D. R. P. 292482, 1916, abst. Chem. Ztg. Rep. 1916, **40**, 275; Zts. Chem. Ind. Koll. 1917, **20**, 62.

Sabalitschka,¹ N. Schoorl and A. Regenbogen,² F. Schuwert,³ V. Sebastian,⁴ E. Schuttlesworth,⁵ L. Solari,⁶ L. Stein,⁷ F. Stockelbach,⁸ Soc. d'Exploit. des Procedes H. Boulard,⁹ E. Elvove,¹⁰ W. Evans and J. Day,¹¹ P. Evans,¹² Ellrodt and Kunz,¹³ A. Jänke,¹⁴ A. Foster,¹⁵ N. Osborne,¹⁶ G. Onsager,¹⁷ K. Ozeki,¹⁸ H. Moore,¹⁹ R. McKee,²⁰ G. Mezzadroll,²¹ J. Magne,²² A. Molhant,²³ W. Owen,²⁴ C. Neuberg and E. Reinfurth,²⁵ E. Leslie,²⁶ T. Lichtenhahn,²⁷ J. Liversege,²⁸ M. Lambert,²⁹ H. Landmark,³⁰ J. Krizek,³¹ F. Kress-

1. Ber. deut. pharm. Ges. 1919, **29**, 214; abst. J. S. C. I. 1919, **38**, 368-A; C. A. 1919, **13**, 2654.

2. Pharm. Weekblad, 1918, **55**, 390; abst. C. A. 1918, **12**, 1522; J. S. C. I. 1918, **37**, 318-A.

3. D. R. P. 311812, 1917; abst. Chem. Zentr. 1919, **90**, IV, 528; J. S. C. I. 1919, **38**, 886-A.

4. Prog. agr. vit. 1914, **61**, 567, 590; abst. J. S. C. I. 1915, **34**, 444. See also F. P. 471784; abst. J. S. C. I. 1915, **34**, 444.

5. Can. Chem. J. 1918, **2**, 91; abst. C. A. 1918, **12**, 1331.

6. Swiss P. 74943; F. P. 484323, 1917; abst. C. A. 1917, **11**, 2807, 1918, **12**, 1050.

7. Pure Products, 1917, **13**, 186; abst. C. A. 1917, **11**, 1718.

8. Amer. Perfumer, 1915, **10**, 94, 109; abst. C. A. 1915, **9**, 2600.

9. E. P. 102945, 1916; abst. C. A. 1917, **11**, 1248; J. S. C. I. 1918, **37**, 525-A.

10. J. Ind. Eng. Chem. 1917, **9**, 295; abst. C. A. 1917, **11**, 1114; J. S. C. I. 1917, **36**, 468.

11. J. A. C. S. 1919, **41**, 1267; abst. J. S. C. I. 1919, **38**, 793-A; Chem. Zentr. 1919, **90**, III, 857.

12. J. Ind. Eng. Chem. 1916, **8**, 260; abst. C. A. 1916, **10**, 1002; J. S. C. I. 1916, **35**, 483.

13. Brenneri Ztg. 1918, 6171; Chem. Ztg. 1919, **43**, 40; J. S. C. I. 1919, **38**, 333-A; abst. C. A. 1919, **13**, 2956.

14. Oesterr. Chem. Ztg. 1918, (2), **21**, 195; abst. Chem. Zentr. 1918, **89**, II, 184.

15. U. S. P. 1320043; abst. C. A. 1920, **14**, 123.

16. U. S. Bureau of Standards, Bull. No. 3, Vol. 9.

17. E. P. 24738, 1913; abst. C. A. 1915, **9**, 1246; J. S. C. I. 1915, **34**, 25.

18. Jap. P. 31355, 1917; abst. C. A. 1918, **12**, 154.

19. U. S. P. 1323540, 1919; abst. C. A. 1920, **14**, 309.

20. U. S. P. 1284739, 1284740, 1918; abst. J. S. C. I. 1919, **38**, 71-A; C. A. 1919, **13**, 186, 187.

21. Boll. chim. farm. 1918, **57**, 361; abst. C. A. 1919, **13**, 1615; J. S. C. I. 1919, **38**, 50-A.

22. Louisiana Planter, 1917, **59**, 13; Intern. Sugar J. 1919, **21**, 466; abst. J. S. C. I. 1919, **38**, 786-A.

23. U. S. P. 1134281, 1915; abst. C. A. 1915, **9**, 1365.

24. Sugar, 1914, **16**, 31; abst. C. A. 1915, **9**, 840, 1365; J. S. C. I. 1914, **33**, 978.

25. Biochem. Zts. 1918, **89**, 365; abst. J. S. C. I. 1918, **37**, 667-A; C. A. 1919, **13**, 2046.

26. Chem. Met. Eng. 1918, **19**, 566; abst. C. A. 1918, **12**, 2324.

27. U. S. P. 1311824, 1919; Can. P. 187609, 1918; abst. C. A. 1919, **13**, 134, 2536.

28. Analyst, 1897, **32**, 154; 1919, **44**, 167; abst. C. A. 1919, **13**, 1971.

29. Ind. Chim. 1918, **5**, 131, 189, 219, 290, 323; 1919, **6**, 178; abst.

mann,¹ J. Kenevel,² B. Kazmann and Kellogg Toasted Corn Flake Co.,³ and L. Kayser,⁴ H. Wood,⁵ A. White⁶ and T. Price,⁶ A. Backhaus and U. S. Industrial Alcohol Co.,⁷ Union Co.,⁸ H. von Schütz,⁹ E. Peytral,¹⁰ E. Pantanelli,¹¹ C. Neuberg,¹² R. McKee,¹³ P. Mandot,¹⁴ J. Magne,¹⁵ E. de Loisy,¹⁶ T. Lichtenhahn,¹⁷ W. Lewis,¹⁸ H. Landmark,¹⁹ I. Kolthoff,²⁰ A. Klein,²¹ K. Hoepner,²² C. Le Petit,²³ T. Craney,²⁴ Hennig and A. Classen,²⁵ E. Bayer and S. Orlajensen,²⁶ E. Barbet et Fils et Cie.²⁷

C. A. 1919, **13**, 2102

30. Pap. tekn. Forening, April 9, 1919, abst. Papierfabr. 1919, **17**, 1052, J. S. C. I. 1919, **38**, 859-A.

31. U. S. P. 1314082, 1919, abst. J. S. C. I. 1919, **38**, 789-A.

1. J. Ind. Eng. Chem. 1915, **7**, 920, abst. C. A. 1916, **10**, 2400; J. S. C. I. 1915, **24**, 1221.

2. U. S. P. 1176150, 1176462, 1916; abst. J. S. C. I. 1916, **35**, 553; C. A. 1916, **10**, 1398, 1399.

3. U. S. P. 1267081, 1918, E. P. 119333, 1917, abst. J. S. C. I. 1918, **37**, 558-A, 711-A; C. A. 1919, **13**, 161. Can. P. 185862, 1918; abst. C. A. 1919, **13**, 161.

4. Feuille d'Informations du Ministre de l'Agric. 1917, **22**, No. 45, 10; Bull. Agr. Intelligence, 1918, **9**, 111, abst. C. A. 1918, **12**, 1585, J. S. C. I. 1918, **37**, 521-A. Ann. Chim. anal. 1919, **1**, 79, abst. J. S. C. I. 1919, **38**, 266-A.

5. J. Amer. Pharm. Assoc. 1919, **8**, 730, abst. C. A. 1920, **14**, 372.

6. J. C. S. 1919, **115**, 1462, abst. J. S. C. I. 1920, **39**, 95-A.

7. E. P. 140796, 140797, 1920.

8. Norw. P. 20231, 1918; abst. C. A. 1920, **14**, 1406.

9. D. R. P. 316346, 1917; abst. J. S. C. I. 1920, **39**, 358-A.

10. Bull. Soc. Chim. 1920, **27**, 34, abst. J. C. S. 1920, **118**, i, 217.

11. Staz. sper. agr. ital. 1918, **51**, 83; Bull. Agr. Intelligence, **10**, 105; abst. C. A. 1920, **14**, 2047.

12. Woch. Brau. 1919, **36**, 202, J. Inst. Brew. 1920, **26**, 99, abst. J. S. C. I. 1920, **39**, 276-A.

13. Can. P. 188636, 188637, 188638. For production of alcohol from seaweed, see E. Bayer and S. Orlajensen. E. P. 119030, 1919, abst. J. S. C. I. 1920, **39**, 499-A.

14. F. P. 455108; abst. C. A. 1914, **8**, 777.

15. Louisiana Planter, 1917, **59**, 13, abst. C. A. 1920, **14**, 794.

16. Compt. rend. 1920, **170**, 50; abst. C. A. 1920, **14**, 1115; J. S. C. I. 1920, **39**, 147-A; Chem. Zentr. 1920, **91**, II, 445.

17. Can. P. 187600, 1918; U. S. P. 1311824, abst. C. A. 1919, **13**, 134, 2536.

18. J. Ind. Eng. Chem. 1920, **12**, 496, abst. C. A. 1920, **14**, 1916, J. S. C. I. 1920, **39**, 463-A.

19. Chem. Ztg. 1915, **39**, 98. Cf. Can. P. 181062.

20. Rec. trav. Chim. 1920, **39**, 126, abst. J. C. S. 1920, **118**, ii, 198.

21. Papierztg. 1918, **43**, 759, 783, 990, 1015; abst. Chem. Zentr. 1918 **89**, II, 416; C. A. 1920, **14**, 467.

22. Zts. Nahr. Genuss. 1917, **34**, 453, abst. C. A. 1920, **14**, 713.

23. E. P. 141091, 1918.

24. U. S. P. 1140502; E. P. 4922, 1915; abst. J. S. C. I. 1915, **34**, 732, 1163.

25. Zts. Spiritusind. 1920, **43**, 19; abst. C. A. 1920, **14**, 2046.

26. Can. P. 196728, 1920.

27. F. P. 478946, 1914; E. P. 107975, 1917; abst. J. S. C. I. 1916, **35** 1173; 1920, **39**, 77-A.

In this connection the various directions for denaturation,¹ excise and trade regulations and statistics,² tax schedules,³ government publications,⁴ special processes of manufacture,⁵ and

1. Oil, Paint and Drug Rep. July 9, 1906; April 29, 1907; Sept. 7, 1907; Dec. 7, 1908; Feb. 1, 1909; 1916, **89**, No. 16, 20, abst. J. S. C. I. 1907, **26**, 1061; 1909, **28**, 35, 214; 1916, **35**, 1596. Zts. Spiritusind. 1902, **25**, 450; 1903, **26**, 389; abst. J. S. C. I. 1902, **21**, 1322, 1903, **22**, 1109. J. S. C. I. 1908, **27**, 703. Drug. Circ. 1912, **56**, 93. Nat. Drug. 1909, **39**, 95. Bd. of Trade J. April 23, 1903, Nov. 7, 1907; abst. J. S. C. I. 1903, **22**, 582, 1907, **26**, 1210. Bd. of Trade J. Dec. **91**, 1913; abst. J. S. C. I. 1913, **32**, 1162. Farben Ztg. 1912, **17**, 1892; abst. C. A. 1912, **6**, 3191. Chem. & Drug. Feb. 10, 1906, Aug. 17, 1907, abst. J. S. C. I. 1906, **25**, 141, 1907, **26**, 934. Pharm. Centralh. 1899, **40**, 199; abst. J. S. C. I. 1902, **21**, 612. J. Ind. Eng. Chem. 1912, **4**, 850. Chem. Met. Eng., 1920, **22**, 517. J. Dobbie, J. S. C. I. 1920, **39**, 86-R, abst. C. A. 1920, **14**, 2235.

2. United States: see Eng. Min. J. Aug. 4, 1906, abst. J. S. C. I. 1906, **25**, 901; Oil, Paint and Drug Rep. Aug. 12, 1907, abst. J. S. C. I. 1907, **26**, 989; Oil, Paint and Drug Rep. Nov. 28, 1910, Nov. 27, 1911, July 27, 1914; abst. J. S. C. I. 1911, **30**, 1466, 1914, **33**, 880. J. Ind. Eng. Chem. **15**, **7**, 637.

England: J. S. C. I. 1908, **27**, 110; Chem. Trade J. Jan. 29, 1900; Pharm. J. Nov. 16, 1912, abst. J. S. C. I. 1912, **31**, 1090. J. S. C. I. 1915, **34**, 53.

France: Times, Aug. 17, 1906, Ch. of Com. J. August, 1907, Zts. Spiritusind. 1908, **31**, 325; Oil, Paint and Drug Rep. Nov. 30, 1908, Zts. Spiritusind. 1909, **32**, 453, Chem. Trade J. Nov. 29, 1913, abst. J. S. C. I. 1906, **25**, 861; 1907, **26**, 939, 1908, **27**, 586, 1217; 1909, **28**, 1099; 1913, **32**, 1123. J. Ind. Eng. Chem. 1913, **5**, 1029.

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Canada: Oil, Paint and Drug Rep., July 9, 1906; abst. J. S. C. I. 1906, **25**, 772. Australia: Bd. of Trade J. Feb. 4, 1915, abst. J. S. C. I. 1915, **34**, 198. Pharm. J. July 7, 1906; abst. J. S. C. I. 1906, **25**, 772. Russia: Bd. of Trade J. Jan. 24, 1907, abst. J. S. C. I. 1907, **26**, 109. India: Chem. and Drug. Aug. 3, 1907; abst. J. S. C. I. 1907, **26**, 934.

3. U. S.: Pharm. J. Aug. 10, 1907; abst. J. S. C. I. 1907, **26**, 939. J. S. C. I. 1919, **38**, 7-R. England: Bd. Trade J. May 13, 1909, abst. J. S. C. I. 1909, **28**, 538. Memorandum of Bd. Customs and Excise, 1914; abst. J. S. C. I. 1914, **33**, 880, 1119, see also J. S. C. I. 1902, **21**, 1216. France: Bd. of Trade J. June 24, 1909; abst. J. S. C. I. 1909, **28**, 732. Bd. of Trade J. Sept. 30, 1909; abst. J. S. C. I. 1909, **28**, 1085. Cf. Bd. of Trade J. Feb. 1, 1906; abst. J. S. C. I. 1906, **25**, 103.

4. Regulations No. 30, Revised, U. S. Internal Revenue, Aug. 22, 1911; and Supplement No. 2, Dec. 10, 1913. See also Treasury Decisions No. 1861, 1876, 1954, June 23, 1913; Sept. 5, 1913; March 10, 1914. Farmers Bull. No. 529, 1911; U. S. Dept. Agric. See J. Ind. Eng. Chem. 1914, **6**, 443. Central Control Bd. of England, "Alcohol, Its Composition and Preparation," abst. C. A. 1918, **12**, 2325. Report of the Departmental Committee on Industrial Alcohol to the Chancellor of the Exchequer, April 11, 1905; J. S. C. I. 1905, **24**, 397. Regulations No. 61 on industrial and denatured alcohol, under Title III, Natl. Prohibition Act.

5. Process Photogram, 1905, **12**, 1. U. S. Dept. Agr., Bur. Chem. Bull. **130**; abst. C. A. 1910, **4**, 809. Chem. Ztg. 1910, **34**, 655; abst. J. S. C. I. 1910, **29**, 855. Neuste Erfind. Erfahr. 1911, **38**, 624. Amer. Distiller's

analysis, are among the suggested uses¹ which may be consulted.

Tables of temperature corrections for the densities of alcohol of sp. gr. 0.79 to 0.99 and from 10° to 25° C. have been published by H. Richmond.²

Propyl Alcohol. Of the two known propyl alcohols, the iso modification has been most exhaustively studied on account of its more ready availability as a constituent of fusel oil. The fundamental groundwork of our knowledge of this alcohol is comprized in the investigations published before 1870. They include, among others, the writings of S. Johnson,³ R. Fittig,⁴ G. Chancel,⁵ A. Perrot,⁶ M. Berthelot,⁷ A. Martin,⁸ E. Erlenmeyer,⁹ M. Simpson,¹⁰ F. Spilsbury and F. Emerson,¹¹ Lorin,¹² E. Linnemann,¹³

Review, 1913, **3**, No. 7, 98, abst. J. Ind. Eng. Chem. 1914, **6**, 86. Bol. Soc. fomento fabrici, Santiago de Chile, 1916, **33**, 40; abst. C. A. 1916, **10**, 1904. Engineer, 1918, **126**, 204; abst. Chem. Zentr. 1919, **90**, II, 183.

1. U. S. Cons. Rep. No. 1288, March 13, 1902, abst. J. S. C. I. 1902, **21**, 538; Chem. Ztg. 1903, **27**, 197; abst. J. S. C. I. 1903, **22**, 410. Engineer, March 6, 1903, 240, abst. J. S. C. I. 1903, **22**, 356. Inland Revenue Report, 1907; abst. J. S. C. I. 1907, **26**, 982. Oil, Paint and Drug Rep. Aug. 16, 1909; abst. J. S. C. I. 1909, **28**, 960. Perf. Essent. Oil Record, **3**, 219; abst. C. A. 1913, **7**, 535. Times Eng. Suppl. Jan. 15, 1913; abst. J. S. C. I. 1913, **32**, 75. Intern. Sugar J. 1916, **18**, 32, abst. C. A. 1916, **10**, 963. Australia Advisory Council Sci. Ind. Bull. **6**, (1918); Expt. Sta. Rec. **38**, 714, abst. C. A. 1918, **12**, 2679. For use of alcohol and pyridine as an illuminant, see Brit. J. Phot. 1900, **47**, 716.

2. Analyst, 1920, **45**, 222; abst. J. S. C. I. 1920, **39**, 525-A.

3. J. prakt. Chem. 1854, **62**, 262; abst. Jahr. Chem. 1854, **7**, 445, 576.

4. Bull. Soc. Chim. 1869, **11**, 276; abst. Chem. Centr. 1869, **40**, 799, 881. See also Ann. 1860, **114**, 66; 1869, **149**, 318; Zts. Chem. 1868, **11**, 44.

5. Compt. rend. 1853, **37**, 410, 1869, **68**, 659, 726, abst. J. C. S. 1853, **6**, 287; Arch. ph. nat. **24**, 385; Bull. Soc. Chim. 1869, **12**, 87; Instit. 1853, 310; Ann. 1853, **87**, 127, 1869, **151**, 298, 304; Chem. Centr. 1853, **24**, 824; 1869, **40**, 884; Jahr. Chem. 1853, **6**, 503; 1869, **22**, 358, J. prakt. Chem. 1853, **60**, 205; Zts. Chem. 1869, **12**, 366.

6. Compt. rend. 1857, **45**, 309, abst. Ann. 1858, **105**, 64, J. prakt. Chem. 1858, **73**, 175; Jahr. Chem. 1857, **10**, 352.

7. Compt. rend. 1855, **40**, 102; 1876, **82**, 297; 1898, **126**, 616, 1899, **129**, 483; abst. Chem. Gaz. 1855, 61; J. C. S. 1898, **74**, i, 393; Ann. Chim. Phys. 1855, **43**, 399; 1876, **9**, 335; Bull. Soc. Chim. 1875, **24**, 530; Instit. 1855, 18; Ann. 1855, **94**, 78; Chem. Centr. 1855, **26**, 109; 1876, **47**, 68, 297, 300; 1899, **70**, II, 802; Bull. Soc. Chim. 1898, **19**, 824; 1899, **21**, 1037; Jahr. Chem. 1855, **8**, 602; 1876, **29**, 98; 1898, **51**, 920; 1899, **52**, 845; J. prakt. Chem. 1855, **65**, 274. See also D. Berthelot, Compt. rend. 1900, **130**, 565; abst. Zts. physik. Chem. 1900, **35**, 103.

8. E. P. 158, 1862.

9. Verhandl. naturhist. Verein in Heidelberg, **3**, 2; Zts. Chem. 1863, **6**, 388; Ann. 1863, **126**, 307; Jahr. Chem. 1863, **16**, 494; J. prakt. Chem. 1863, **90**, 315; Chem. Centr. 1864, **35**, 17; Bull. Soc. Chim. 1866, **5**, 617; Phil. Mag 1864, **27**, 108.

10. Proc. Roy. Soc. 1863, **12**, 533; Ann. Chim. Phys. 1863, **69**, 383; Ann. 1866, **139**, 127; Chem. Centr. 1864, **35**, 545; Bull. Soc. Chim. 1866,

E. Frankland and B. Duppa,¹ I. Pierre and E. Puchot,² R. Fittig, J. König and H. Schäffer,³ L. Henry,⁴ H. Buff,⁵ A. Butlerow and M. Ossokin,⁶ D. Mendelejeff,⁷ A. Siersch,⁸ C. Schorlemmer,⁹ and E. Linnemann and A. Siersch.¹⁰

From 1870 to 1890 saw a noticeably quickening interest in this body from the patents issued during this period for the utilization of the alcohols of fusel oil as solvents for the nitrocelluloses after esterification and in this advance, propyl alcohol is included. The increment of knowledge upon this subject is reflected in the

6, 38, *Jahr. Chem.* 1863, **16**, 494.

11. E. P. 1232, 1862.

12. *Compt. rend.* 1863, **56**, 845, abst. *J. prakt. Chem.* 1863, **90**, 57; *Jahr. Chem.* 1863, **16**, 327.

13. *Ann.* 1863, **125**, 307; 1865, **136**, 40; 1868, **148**, 251; 1869, **150**, 370, **152**, 127; 1870, **154**, 130, 367; 1871, **157**, 119, 120; **160**, 195, 238; 1872, **161**, 18, 43, 178, 190; **162**, 1, 12; abst. *J. prakt. Chem.* 1863, **89**, 177, 1874, **413**, 160; *Ber.* 1874, **7**, 856; 1877, **10**, 1111, *Wien Akad. Ber.* **75**, II, 906; *Jahr. Chem.* 1868, **21**, 432; 1869, **22**, 364, 1870, **23**, 487; 1871, **24**, 40, 381, 397; 1872, **25**, 35, 309, 338, 343; 1874, **27**, 341; 1877, **30**, 523; *Chem. Centr.* 1869, **40**, 891; 1870, **41**, 367, 449; 1872, **43**, 20, 80, 84, 91, 95, 329, 330, 680. *Ann. Chim. Phys.* 1869, **17**, 434, *Bull. Soc. Chim.* 1869, **12**, 272, *Zts. Chem.* 1870, **13**, 682; 1871, **14**, 571. See also E. Linnemann and V. von Zotta, *Ann.* 1869, **152**, 127; 1872, **162**, 3; *Jahr. Chem.* 1872, **25**, 342. Cf. B. Tollens, *Jahr. Chem.* 1873, **26**, 327. V. Meyer, J. Barbieri and F. Forster, *Ber.* 1877, **10**, 130.

1. J. C. S. 1867, **20**, 102; *Ann.* 1868, **145**, 78, abst. *Jahr. Chem.* 1867, **20**, 394.

2. *Compt. rend.* 1869, **69**, 95; 1870, **70**, 354; 1871, **73**, 599, 778; 1872, **74**, 511, *Ann. Chim. Phys.* 1872, **25**, 236, *Bull. Soc. Chim.* 1869, **11**, 43; 1870, **14**, 53; abst. *Chem. Centr.* 1869, **40**, 883, *Jahr. Chem.* 1869, **22**, 360; 1870, **23**, 421; 1871, **24**, 39; 1872, **25**, 317, *Zts. Chem.* 1871, **14**, 470, 477.

3. *Bull. Soc. Chim.* 1868, **10**, 42, abst. *Jahr. Chem.* 1868, **21**, 435; *Zts. Chem.* 1868, **11**, 44.

4. *Ber.* 1869, **2**, 495, abst. *Chem. Centr.* 1869, **40**, 900. *Compt. rend.* 1904, **138**, 205; 1907, **145**, 453, abst. J. C. S. 1905, **88**, i, 558, 1907, **92**, i, 887.

5. *Ann.* 1867, Suppl. **5**, 247, abst. *Zts. Chem.* 1868, **11**, 124; *Chem. Centr.* 1868, **39**, 221; *Bull. Soc. Chim.* 1868, **10**, 213, *Amer. J. Sci. (Sill.)*, 1868, **45**, 256; *Jahr. Chem.* 1868, **21**, 574.

6. *Ann.* 1868, **145**, 257, abst. *Chem. Centr.* 1868, **39**, 742. See also *Ann.* 1867, **144**, 42; abst. *Chem. Centr.* 1868, **39**, 463.

7. *Zts. Chem.* 1868, **11**, 25; abst. *Bull. Soc. Chim.* 1868, **10**, 44; *Jahr. Chem.* 1867, **20**, 566.

8. *Ann.* 1867, **142**, 155; 1868, **147**, 261; abst. *J. prakt. Chem.* 1867, **102** 311; *Zts. Chem.* 1867, **10**, 248; 1869, **12**, 145; *Ann. Chim. Phys.* 1867, **12**, 485; *Bull. Soc. Chim.* 1868, **9**, 136, *Jahr. Chem.* 1867, **20**, 532, 1868, **21**, 436; *Chem. Centr.* 1869, **40**, 897, 900.

9. *Zts. Chem.* 1868, **11**, 49; *Bull. Soc. Chim.* 1868, **10**, 44; *Chem. News*, 1872, **25**, 101; abst. *Jahr. Chem.* 1872, **25**, 34.

10. *Ann.* 1867, **144**, 137; abst. *Chem. Centr.* 1868, **39**, 384; *Zts. Chem.* 1869, **12**, 143. E. Linnemann and V. von Zotta, *Wien. Akad. Sitzber.* **63**, 423; abst. *Chem. Centr.* 1871, **42**, 596. E. Linnemann and C. Friedel, *Ann.* 1865, **133**, 133; *Compt. rend.* 1864, **60**, 346; abst. *Chem. Centr.* 1865, **36**, 461.

publications of A. Rossi,¹ C. Friedel and R. Silva,² E. Hardy,³ C. Bouchardat,⁴ A. Cahours,⁵ B. Tollens,⁶ G. Kraemer⁴ and A. Pinner,⁷ H. Grimshaw and C. Schorlemmer,⁸ A. Saytzeff and A. Rossi,⁹ A. Saytzeff,¹⁰ C. Schmitt,¹¹ S. Pagliani,¹² V. Meyer and F. Forster,¹³ C. Counciler,¹⁴ G. Niederist,¹⁵ A. Villiers,¹⁶ R. Pribram and A. Handl,¹⁷ W. Perkin,¹⁸ B. Pawlewski,¹⁹ F. Zettermann,²⁰ A. Zander,²¹ J. Brühl,²² W. Jahn,²³ S. Wiegand and S. Henrichsen,²⁴

1. *Gaz. chim. ital.* 1871, **1**, 230; *J. prakt. Chem.* 1871, **111**, 455; *Ann.* 1871, **159**, 79; *abst. Chem. Centr.* 1870, **41**, 347, 1871, **42**, 498.

2. *Compt. rend.* 1873, **76**, 226; *abst. Jahr. Chem.* 1873, **26**, 306; *Bull. Soc. Chim.* 1873, **19**, 289; *Ber.* 1873, **6**, 267; *Chem. Centr.* 1873, **44**, 211.

3. *Compt. rend.* 1874, **79**, 806; *abst. Chem. Centr.* 1874, **45**, 705; *Jahr. Chem.* 1874, **27**, 305; *Jahr. reu. Chem.* 1874, **2**, 158.

4. *Compt. rend.* 1874, **78**, 1145; *abst. Chem. Centr.* 1874, **45**, 322; *Jahr. Chem.* 1874, **27**, 950; *J. C. S.* 1874, **27**, 883.

5. For other *propyl* derivatives see *Compt. rend.* 1873, **76**, 133, 748, 1383; *abst. Jahr. Chem.* 1873, **26**, 516.

6. *Bull. Soc. Chim.* 1868, **10**, 394; *Compt. rend.* 1869, **68**, 268; *Ann.* 1867, **144**, 159; *Ber.* 1869, **2**, 40; *abst. Chem. Centr.* 1870, **41**, 5, 387, 658; *Zts. Chem.* 1870, **13**, 267, 458.

7. *Zts. Chem.* 1870, **13**, 470; *abst. Jahr. Chem.* 1870, **23**, 445.

8. *Ann.* 1873, **170**, 137; *abst. Chem. Centr.* 1873, **44**, 802. See also *K. Akad. Wien Anzeiger*, 1870, 161; *abst. Chem. Centr.* 1870, **41**, 545.

9. *Compt. rend.* 1870, **70**, 129; *Zts. Chem.* 1870, **13**, 140; *Ann.* 1871, **159**, 79; *abst. Jahr. Chem.* 1870, **23**, 443. See also *Jahr. Chem.* 1868, **21**, 432, 434, 1869, **22**, 358.

10. *Zts. Chem.* 1870, **13**, 105; *J. prakt. Chem.* 1871, **111**, 76; *abst. Chem. Centr.* 1870, **41**, 177, 1871, **42**, 227.

11. *Zts. Chem.* 1870, **13**, 576; *abst. Chem. Centr.* 1870, **41**, 819; *Jahr. Chem.* 1870, **23**, 445.

12. *Ber.* 1878, **11**, 155; *Jahr. Chem.* 1878, **31**, 837. *Ann. Phys. Beibl.* 1883, **7**, 449; *N. Comento*, 1883, **12**, 229; *abst. Jahr. Chem.* 1883, **36**, 122. S. Pagliani and A. Emc, *Ann. Phys. Beibl.* 1884, **8**, 18; *abst. Jahr. Chem.* 1884, **37**, 904.

13. *Ber.* 1876, **9**, 529; *abst. Jahr. Chem.* 1876, **29**, 321. See also *Jahr. Chem.* 1872, **25**, 287.

14. *Ber.* 1878, **11**, 1107; *abst. Chem. Centr.* 1878, **49**, 563; *J. C. S.* 1878, **34**, 512; *Jahr. Chem.* 1878, **31**, 523.

15. *Ann.* 1877, **166**, 391; *abst. Jahr. Chem.* 1877, **30**, 522.

16. *Ann. Chim. Phys.* 1880, **21**, 72; *Ber.* 1880, **13**, 1743, 1891; *abst. Jahr. Chem.* 1880, **33**, 595.

17. *Wien Akad. Ber.* **84**, II, 717; *abst. Jahr. Chem.* 1881, **34**, 85.

18. *Ber.* 1882, **15**, 1363; *J. C. S.* 1882, **41**, 330; *abst. Jahr. Chem.* 1882, **35**, 198. *Zts. physik. Chem.* 1896, **21**, 584, 626.

19. *Ber.* 1884, **17**, 1606; *abst. Jahr. Chem.* 1884, **37**, 904.

20. *Ann. Phys. Beibl.* 1881, **5**, 737; *J. phys.* 1881, **10**, 312; *abst. Jahr. Chem.* 1881, **34**, 1096.

21. *Ann.* 1882, **214**, 27, 1884, **224**, 56; *abst. Jahr. Chem.* 1882, **35**, 27; 1884, **37**, 79.

22. *Ann.* 1886, **203**, 268. *Zts. physik. Chem.* 1891, **7**, 153, 156; 1898, **26**, 650.

23. *Wien. Akad. Ber.* **81**, II, 750; **82**, II, 511; *Monatsh.* 1880, **1**, 378, 675; *Chem. Centr.* 1880, **51**, 323, 585; *Ber.* 1880, **13**, 983, 2107; *Jahr. Chem.* 1880, **33**, 390.

24. *Ann. Phys.* 1884, (2), **22**, 121; *abst. Jahr. Chem.* 1884, **37**, 280.

- A. Nadejdine,¹ A. Naccari and S. Pagliani,² G. Kahlbaum,³ J. Kerr,⁴ D. Konowalów,⁵ A. Destrem,⁶ D. Diakonoff,⁷ J. Groshans,⁸ U. Gayon and G. Dupetit,⁹ P. Albertoni,¹⁰ R. Schiff,¹¹ S. Ruhemann and D. Carnegie,¹² S. Pagliani and A. Batelli,¹³ S. Pagliani and L. Palazzo,¹⁴ R. Pribram,¹⁵ R. de Forcrand,¹⁶ N. Menshutkin,¹⁷ S. Henrichsen,¹⁸ A. Bonz,¹⁹ E. Conrady,²⁰ J. Crafts,²¹ J. Traube,²² R. Weegmann,²³ U. Gayon and E. Dulorg,²⁴ A. Stohmann,²⁵ S.
1. Ann Phys Beibl 1883, **7**, 678; J. Russ. Phys. Chem. Soc. 1882, **14**, 57, 536; 1883, **15**, 25, abst. Jahr. Chem. 1883, **36**, 134; Rep. phys. 1881, **20**, 441; abst. Ann. Phys. Beibl. 1885, **9**, 109; Jahr. Chem. 1885, **38**, 131; Zts. physik. Chem. 1891, **7**, 605; 1903, **44**, 552.
 2. Ann. Phys. Beibl. 1882, **6**, 87, abst. Jahr. Chem. 1882, **35**, 63; Zts. physik. Chem. 1893, **12**, 467; 1903, **43**, 286.
 3. Ber. 1883, **16**, 2476, abst. Jahr. Chem. 1883, **36**, 126; Bull. Soc. Chim. 1884, **41**, 210; Zts. physik. Chem. 1891, **8**, 637; 1898, **26**, 650.
 4. Phil. Mag. 1882, **13**, 153, 248, abst. Jahr. Chem. 1883, **36**, 196.
 5. Wied. Ann. 1881, **14**, 34; Bull. Soc. Chim. 1881, **35**, 169, abst. Jahr. Chem. 1882, **35**, 57.
 6. Ann. Chim. Phys. 1882, **27**, 5, abst. Jahr. Chem. 1882, **35**, 612.
 7. Bull. Soc. Chim. 1882, **38**, 172, abst. Jahr. Chem. 1882, **35**, 107; J. C. S. 1882, **42**, 355; J. Russ. Phys. Chem. Soc. 1882, **14**, 2.
 8. Rec. trav. Chim. Pays-Bas, 1884, **3**, 105, abst. Jahr. Chem. 1884, **37**, 46.
 9. Compt. rend. 1882, **95**, 644, abst. Jahr. Chem. 1882, **35**, 1235; Bull. Soc. Chim. 1883, **39**, 555; Chem. Centr. 1882, **53**, 804.
 10. Riv. med. farm. **1**, 413, **2**, 153, 233, 382; Arch. exper. Pathol. Pharm. **18**, 218; Italia med. 1883, Allgem. med. Centralztg. **53**, 6, abst. Chem. Centr. 1884, **55**, 142; Jahr. Chem. 1883, **36**, 1479; 1884, **37**, 1500.
 11. Ber. 1882, **35**, 1270, 2965; Ann. 1883, **220**, 71, 278; 1884, **223**, 47; Gaz. chim. ital. 1884, **14**, 292, abst. Jahr. Chem. 1882, **35**, 27, 67; 1883, **36**, 64; 1884, **37**, 101.
 12. J. C. S. 1888, **53**, 424; Chem. News, 1888, **57**, 116, abst. Chem. Centr. 1888, **59**, 541.
 13. Ann. Phys. Beibl. 1886, **10**, 81, 221, abst. Jahr. Chem. 1886, **39**, 113.
 14. Ann. Phys. Beibl. 1885, **9**, 149, abst. Jahr. Chem. 1885, **38**, 107.
 15. Wien. Akad. Ber. 1888, **97**, II, 116, abst. Zts. physik. Chem. 1888, **2**, 970.
 16. Compt. rend. 1885, **101**, 161, 318; 1887, **104**, 291, 361; 1892, **114**, 301; 1899, **130**, 1758; Ann. Chim. Phys. 1884, **3**, 129; 1892, **27**, 525; abst. Chem. Centr. 1885, **56**, 660; 1887, **58**, 267, 297; 1892, **63**, I, 47; 1893, **64**, I, 205; Jahr. Chem. 1885, **38**, 208; 1900, **53**, 579.
 17. Zts. physik. Chem. 1887, **1**, 612, 613, 617, 620; 1892, **9**, 237; 1899, **28**, 677, 678; 1900, **34**, 154.
 18. Wied. Ann. 1888, **34**, 180, abst. Zts. physik. Chem. 1888, **2**, 548.
 19. Zts. physik. Chem. 1888, **2**, 893; abst. J. C. S. 1889, **56**, 335.
 20. Zts. physik. Chem. 1889, **3**, 216, 223. Cf. Ann. 1888, **246**, 223.
 21. Zts. physik. Chem. 1887, **1**, 420; Ber. 1887, **20**, 709. Cf. G. Kahlbaum, Ber. 1886, **19**, 3100.
 22. Ber. 1886, **19**, 871; abst. Jahr. Chem. 1886, **39**, 118, 119; Zts. physik. Chem. 1903, **43**, 288, 289.
 23. Zts. physik. Chem. 1888, **2**, 268; abst. J. C. S. 1888, **54**, 990.
 24. Compt. rend. 1886, **102**, 978; abst. Jahr. Chem. 1886, **39**, 1884.
 25. J. prakt. Chem. 1885, **140**, 420, abst. Jahr. Chem. 1885, **38**, 197; Zts. physik. Chem. 1888, **2**, 30.

Arrhenius,¹ and including the investigations of M. Le Blanc.²

The period 1891 to 1900 developed no particularly noteworthy achievement in the chemistry or commercial utilization of this alcohol, the tendency being to increase the sphere of usefulness in the fields then known. The progress is recorded in the disclosures of A. Schlamp,³ G. Schmidt,⁴ W. Röntgen and L. Zehnder,⁵ W. Ramsay,⁶ W. Ramsay and J. Shields,⁷ W. Ramsay and S. Young,⁸ Chem. Fabr. auf Actien vorm. F. Schering,⁹ S. Young,¹⁰ E. Mathias,¹¹ P. Henry,¹² A. Handl and R. Pribram,¹³ A. Etard,¹⁴ P. Barbier and L. Roux,¹⁵ B. von Bitto,¹⁶ H. Jones,¹⁷ J. Thomsen,¹⁸ T. Thorpe and L. Jones,¹⁹ C. Thwing,²⁰ A. Winkelmann,²¹ L. Niemiłowicz,²² L. Kossakowsky,²³ D. Konowalow and A. Winkelmann,²⁴

1. Zts. physik. Chem. 1887, **1**, 288, 289, 290; 1888, **2**, 494, 495; 1892, **9**, 489, 492, 503, 505.

2. Zts. physik. Chem. 1889, **4**, 554, abst. J. C. S. 1890, **58**, 313.

3. Zts. physik. Chem. 1894, **14**, 276, 278, 279, 280, 281, 282; abst. J. C. S. 1894, **66**, ii, 376.

4. Zts. physik. Chem. 1891, **8**, 637; abst. J. C. S. 1891, **60**, 969.

5. Wied. Ann. Phys. 1891, **44**, I, 24; abst. Zts. physik. Chem. 1892, **9**, 226.

6. Zts. physik. Chem. 1894, **15**, 108. Cf. S. Young and G. Thomas, J. C. S. 1893, **63**, 1251.

7. J. C. S. 1893, **63**, 1089; Zts. physik. Chem. 1893, **12**, 467, 468.

8. Trans. Roy. Soc. 1889, **180**, 156; abst. Zts. physik. Chem. 1891, **7**, 605, 611.

9. E. P. 10112, 1894; abst. J. S. C. I. 1894, **13**, 687; 1895, **14**, 539.

10. Zts. physik. Chem. 1893, **10**, 793, 1893, **11**, 285; Phil. Mag. 1893, **34**, 503. J. C. S. 1902, **81**, 777, abst. Zts. physik. Chem. 1903, **43**, 125. Cf. Phil. Mag. 1885, **20**, 515; abst. Zts. physik. Chem. 1887, **1**, 420. Sci. Proc. Roy. Dublin Soc. 1910, **12**, 442.

11. Compt. rend. 1892, **115**, 35, abst. Zts. physik. Chem. 1892, **10**, 793.

12. Arch. Pharm. 229, 486; abst. Chem. Centr. 1891, **62**, II, 690.

13. Zts. physik. Chem. 1892, **9**, 538; abst. J. C. S. 1892, **62**, 1143.

14. Compt. rend. 1892, **114**, 753; abst. Chem. Centr. 1892, **63**, I, 738; Jahr. Chem. 1892, **45**, 1543; Bull. Soc. Chim. 1893, **9**, 879; J. C. S. 1892, **62**, 809.

15. Bull. Soc. Chim. 1890, **4**, 9, abst. Jahr. Chem. 1890, **43**, 390; Chem. Centr. 1890, **61**, II, 291; J. C. S. 1890, **58**, 1034. See also Compt. rend. 1890, **110**, 457, 527, 1071; **111**, 180, 235; Bull. Soc. Chim. 1890, **3**, 255, 419, 424; **4**, 9, 614, 620.

16. Chem. Ztg. 1893, **17**, 611; abst. Chem. Centr. 1893, **64**, II, 157.

17. Zts. physik. Chem. 1893, **12**, 646; abst. J. C. S. 1893, **64**, ii, 263, 366, 447; 1894, **66**, ii, 83.

18. See F. Stohmann, Zts. physik. Chem. 1890, **6**, 339.

19. J. C. S. 1893, **63**, 273; abst. Zts. physik. Chem. 1893, **11**, 840.

20. Zts. physik. Chem. 1894, **14**, 293; abst. J. C. S. 1894, **66**, ii, 374.

21. Wied. Ann. Phys. 1890, **39**, I, 1; abst. Zts. physik. Chem. 1890, **5**, 283; 1891, **8**, 171.

22. Monatsh. 1889, **10**, 813; abst. Chem. Centr. 1890, **61**, I, 580.

23. Zts. physik. Chem. 1891, **8**, 268; abst. J. C. S. 1891, **60**, 1316.

24. Wied. Ann. Phys. 1881, **14**, 42; 1890, **39**, 10; abst. Zts. physik. Chem. 1891, **8**, 126.

E. Paterno,¹ P. de Heen,² C. Guldberg,³ R. Gartenmeister,⁴ C. Goettig,⁵ M. Dennstedt,⁶ P. Guye,⁷ R. Abegg,⁸ G. Link and R. Avenarius,⁹ H. Landolt and H. Jahn,¹⁰ F. Schütt,¹¹ I. Schröder,¹² O. Schönrock,¹³ W. Louguinine,¹⁴ G. Schmidt,¹⁵ W. Russell and W. Lapraik,¹⁶ J. Phillip,¹⁷ E. Franklin and C. Kraus,¹⁸ A. von Hemp-
tinne,¹⁹ H. Barendrecht,²⁰ W. Biltz,²¹ S. Bigelow,²² L. Bauner,²³ E. Beckmann and G. Fuchs,²⁴ E. Beckmann and V. Gernhardt,²⁵ G.

1. Gaz. chim. ital. 1889, **19**, 44; abst. Zts. physik. Chem. 1890, **5**, 94; 1893, **12**, 694.
2. Zts. physik. Chem. 1891, **7**, 605.
3. Zts. physik. Chem. 1890, **5**, 374; 1891, **7**, 605; 1900, **32**, 121, 123.
4. Zts. physik. Chem. 1890, **6**, 529, 532; abst. J. C. S. 1891, **60**, 380.
5. Ber. 1890, **23**, 181; abst. Jahr. Chem. 1890, **43**, 1126; Bull. Soc. Chim. 1890, **3**, 803; Chem. Centr. 1890, **61**, I, 466.
6. Ber. 1892, **25**, 3636; abst. Chem. Centr. 1893, **64**, I, 295.
7. Compt. rend. 1890, **110**, 141; abst. Zts. physik. Chem. 1890, **5**, 276.
8. Zts. physik. Chem. 1894, **15**, 218, 219; abst. J. C. S. 1895, **68**, ii, 71.
9. E. P. 115, 1891; abst. J. S. C. I. 1891, **10**, 85, 404, 571.
10. Zts. physik. Chem. 1892, **10**, 302, 316, 317; abst. Jahr. Chem. 1892, **45**, 473; Chem. Centr. 1892, **63**, II, 817. See also Zts. physik. Chem. 1891, **7**, 150.
11. Zts. physik. Chem. 1892, **9**, 350, 351, 354; abst. J. C. S. 1892, **62**, 929.
12. Zts. physik. Chem. 1893, **11**, 456; abst. J. C. S. 1893, **64**, ii, 366.
13. Zts. physik. Chem. 1893, **11**, 759. See also D. Mendeleeff, Zts. Chem. 1868, **11**, 25; abst. Jahr. Chem. 1867, **20**, 566; Bull. Soc. Chim. 1868, **10**, 44.
14. Zts. physik. Chem. 1890, **6**, 339; 1895, **17**, 176, 511; 1904, **49**, 37. See also Ann. Chim. Phys. 1880, **21**, 141. G. Bouchardat, Compt. rend. 1871, **73**, 199; Ann. 1871, **160**, 338; Bull. Soc. Chim. 1871, **15**, 21; Chem. Centr. 1871, **42**, 482; Zts. Chem. 1871, **14**, 349; Compt. rend. 1871, **73**, 1008; abst. Bull. Soc. Chim. 1871, **16**, 38; Zts. Chem. 1871, **14**, 431; Jahr. Chem. 1871, **24**, 791. Compt. rend. 1874, **78**, 1145; abst. Chem. Centr. 1874, **45**, 322.
15. Zts. physik. Chem. 1891, **8**, 628, 634, 646; abst. J. C. S. 1891, **60**, 969; 1892, **62**, 262, 396.
16. J. C. S. 1882, **41**, 334; abst. Rev. trav. Chim. Pays-Bas, 1897, **16**, 1; Zts. physik. Chem. 1898, **27**, 177.
17. Zts. physik. Chem. 1897, **24**, 35; abst. J. C. S. 1898, **74**, ii, 9.
18. Amer. Chem. J. 1898, **20**, 836; abst. Jahr. Chem. 1898, **51**, 421; Zts. physik. Chem. 1899, **29**, 354.
19. Zts. physik. Chem. 1898, **25**, 291; abst. Jahr. Chem. 1898, **51**, 832. A. v. Hempinnee and A. Bekaert, Zts. physik. Chem. 1899, **28**, 232.
20. Zts. physik. Chem. 1896, **20**, 234; abst. Chem. Centr. 1896, **67**, II, 534.
21. Zts. physik. Chem. 1899, **29**, 249; abst. Chem. Centr. 1899, **70**, I, 331; J. C. S. 1899, **76**, i, 297; Jahr. Chem. 1899, **52**, 54.
22. Zts. physik. Chem. 1898, **26**, 528; abst. J. C. S. 1898, **74**, ii, 506.
23. Zts. physik. Chem. 1898, **26**, 145; abst. Jahr. Chem. 1898, **51**, 383; Chem. Centr. 1898, **69**, II, 255; J. C. S. 1898, **74**, ii, 422.
24. Zts. physik. Chem. 1895, **18**, 501. See also Heffter and Juckenack, Vrtljschr. f. Ger. Med. u. öffentl. Sanitätswesen, 1919, **58**, 1; abst. C. A. 1920, **14**, 590.
25. Zts. physik. Chem. 1895, **18**, 482, 483; abst. J. C. S. 1896, **70**, ii, 236.

Carrara,¹ T. Thorpe,² S. Tereschin,³ R. Nasini,⁴ J. Kuenen and W. Robson,⁵ E. Kaiser,⁶ P. Drude,⁷ F. Gaud,⁸ P. Guzzi,⁹ R. Abegg and W. Seitz,¹⁰ P. Subow,¹¹ W. Spring,¹² and C. Speyers.¹³

From 1901 up to the present time, the researches on the two propyl alcohols, especially in connection with their uses in conjunction with the cellulose esters have, comparatively speaking, been limited to a large number of relatively minor investigations, as is indicated by the publications of H. Euler,¹⁴ P. Raikow,¹⁵ G. Rudorf,¹⁶ T. Richards,¹⁷ M. Friedlander,¹⁸ J. von Zawidzki,¹⁹ S. Young and E. Fortey,²⁰ E. Merk,²¹ S. Hedin,²² C.

1. *Gazz. chim. ital.* 1891, **24**, 1, abst. *Zts. physik. Chem.* 1895, **16**, 735.
2. *J. C. S.* 1897, **71**, 920, abst. *Zts. physik. Chem.* 1897, **24**, 562, *Chem. Centr.* 1897, **68**, II, 612, 541, *Jahr. Chem.* 1897, **50**, 1142.
3. *Wied. Ann. Phys.* 1889, **36**, 792, abst. *Zts. physik. Chem.* 1897, **23**, 309.
4. *Zts. physik. Chem.* 1895, **16**, 248, abst. *J. C. S.* 1894, **66**, ii, 173.
5. *Zts. physik. Chem.* 1899, **28**, 360, *Phil. Mag.* 1902, **4**, 116, abst. *Chem. Centr.* 1902, **73**, II, 419, *Jahr. Chem.* 1902, **55**, 41, *Zts. physik. Chem.* 1903, **45**, 254.
6. *Amer. Chem. J.* 1896, **18**, 328, abst. *Jahr. Chem.* 1897, **50**, 1102.
7. *Zts. physik. Chem.* 1897, **23**, 309, 1899, **28**, 677, 678, abst. *Chem. Centr.* 1897, **68**, II, 247, *Jahr. Chem.* 1897, **50**, 246.
8. *Compt. rend.* 1894, **119**, 862, abst. *Chem. Centr.* 1895, **66**, I, 14, *J. C. S.* 1895, **68**, i, 197, *Bull. Soc. Chim.* 1895, **13**, 159.
9. *Gazz. chim. ital.* 1898, **28**, II, 501, abst. *Chem. Centr.* 1899, **70**, I, 609. Cf. *Atti R. Accad. dei Lincei Roma* (5), **7**, 215, *Gazz. chim. ital.* 1898, **28**, I, 297, abst. *Chem. Centr.* 1898, **69**, I, 1107, II, 189.
10. *Zts. physik. Chem.* 1899, **29**, 245, abst. *J. C. S.* 1899, **76**, ii, 623.
11. *J. Russ. Phys. Chem. Soc.* 1898, **30**, 926, abst. *Zts. physik. Chem.* 1899, **29**, 752.
12. *Arch. phil. nat.* (4), **3**, 437, abst. *Jahr. Chem.* 1897, **50**, 211; *Zts. physik. Chem.* 1898, **27**, 177, *Rec. trav. Chim. Pays-Bas*, 1897, **16**, 1.
13. *J. A. C. S.* 1896, **18**, 142, abst. *Jahr. Chem.* 1897, **50**, 1056. See H. Euler, *Zts. physik. Chem.* 1901, **36**, 408.
14. *Zts. physik. Chem.* 1901, **36**, 656, abst. *J. C. S.* 1901, **80**, ii, 57, 376. See R. Cornelison, *U. S. P.* 816648, 1906.
15. *Chem. Ztg.* 1902, **26**, 436, abst. *Jahr. Chem.* 1902, **55**, 773.
16. *Zts. physik. Chem.* 1903, **43**, 287, abst. *J. C. S.* 1903, **84**, ii, 403. The cellulose nitrate solvent combination of H. Dow (*U. S. P.* 1339552, abst. *C. A.* 1920, **14**, 2084) consists of propyl alcohol 55, ethylene chlorbromide 45, and benzyl acetate 5 parts.
17. *Zts. physik. Chem.* 1904, **49**, 34, 37, abst. *J. C. S.* 1903, **84**, ii, 132.
18. Dissertation, Berlin, 1888, abst. *Jahr. Chem.* 1888, **41**, 2450, *Chem. Centr.* 1888, **59**, 674.
19. *Zts. physik. Chem.* 1903, **46**, 23, 25, 26, 28. See also C. Holley, *J. A. C. S.* 1902, **24**, 448.
20. *J. C. S.* 1902, **81**, 717, 739; abst. *Jahr. Chem.* 1902, **55**, 36, *Zts. physik. Chem.* 1903, **43**, 124.
21. *D. R. P.* 113719, abst. *Chem. Centr.* 1900, **71**, 794, *Wag. Jahr.* 1900, **46**, II, 3.
22. *Pflueger's Archiv* **78**, 205; abst. *Chem. Centr.* 1900, **71**, I, 206, *Jahr. Chem.* 1900, **53**, 520.

Holley,¹ K. Meyer,² H. Hofer and M. Moest,³ F. Hofmann and O. Bonhoeffer,⁴ G. Heinrich,⁵ K. Elbs and K. Brand,⁶ Farbenfabr. vorm. F. Bayer & Co.,⁷ H. Buchner, F. Fuchs and L. Megele,⁸ H. Jones and C. Lindsay,⁹ J. Cavalier and E. Prost,¹⁰ G. Carrara and A. Coppadoro,¹¹ J. Tafel and K. Schmitz,¹² A. Trillat,¹³ G. Wirgin,¹⁴ P. Walden,¹⁵ G. Newth,¹⁶ A. Klinge,¹⁷ T. Patterson,¹⁸ P. Guye and L. Friderich,¹⁹ M. Deniges,²⁰ M. Guerbet,²¹ V. Grignard,²²

- 1 J A C S 1902, **24**, 448, abst Zts physik Chem 1903, **42**, 540, **46**, 25
- 2 Zts physik Chem 1900, **32**, 15, 16, 25, 30, abst J C S 1900, **78**, n, 263
- 3 Ann 1902, **323**, 284, abst Jahr Chem 1902 **55**, 769, Chem Centr. 1902, **73**, II, 1094
- 4 U S P 7 2430, abst Mon Sci 1904, **61**, 34, Chem Zts 1904, **3**, 244, J A C S 1904, **26R**, 233
- 5 Sitzber Bayer Akad 1900, **30**, 35, abst Zts physik Chem 1901, **37**, 227
- 6 Zts Elektrochem 1902, **8**, 783, abst Chem Centr 1902, **73**, II, 1199, Jahr Chem 1902, **55**, 1439
- 7 D R P 151545, 1903, abst Wag Jahr 1904, **50**, II, 83, Chem Centr 1904, **75**, I, 1586, Chem Ztg 1904, **28**, 532, Zts ang Chem 1904, **17**, 1493, Jahr Chem 1904, **57**, 859, Mon Ser 1905, **63**, 60
- 8 Arch Hyg **40**, 347, abst Chem Centr 1901, **72**, II, 1234, J C S 1901, **80**, n, 562, Jahr Chem 1901, **54**, 611
- 9 Amer Chem J 1902, **28**, 329, abst J C S 1903, **84**, n, 55, Zts physik Chem 1904, **47**, 239
- 10 Bull Soc Chim 1900, **23**, 678, abst Jahr Chem 1900, **53**, 616
- 11 Mem R Acad Lincei, 1901, 317, abst Zts phys Chem 1903, **44**, 380, Gaz chim ital 1903, **33**, I, 329, abst Jahr Chem 1903, **56**, 725, Chem Centr 1903, **74**, II, 615, Bull Soc Chim 1904, **34**, 770, J C S 1903, **84**, n, 712
- 12 Zts Elektrochem 1902, **8**, 281, abst Jahr Chem 1902, **55**, 197
- 13 Compt rend 1901, **132**, 1495, abst Chem Centr 1901, **72**, II, 178, Cf J. Trillat, Compt rend 1901, **132**, 1227, abst Chem Centr 1901, **72**, II, 26
- 14 Zts Hyg, 1904, **46**, 149, abst Chem Centr 1904, **75**, II, 55
- 15 Zts physik Chem 1903, **46**, 172, abst J C S 1904, **86**, n, 227
- 16 J. C. S. 1901, **79**, 915, abst Jahr Chem 1901, **54**, 580
- 17 Compt rend 1902, **135**, 970, Bull Soc Chim 1903, **29**, 92, Chem Centr. 1903, **74**, I, 132
- 18 J C S. 1901, **79**, 477, 971, abst Jahr Chem 1901, **54**, 61, Zts. physik Chem 1901, **37**, 632
- 19 Arch sci phys (Geneva) 1900, **9**, 22, abst Zts physik Chem 1903, **46**, 172
- 20 Compt. rend. 1904, **138**, 1607, Jahr Chem 1904, **57**, 861, J C S 1904, **86**, i, 706, Bull Soc Chim 1904, **31**, 1343, Chem Centr 1904, **75**, II, 413
- 21 Bull Soc Chim 1902, **27**, 1034, abst J C S 1903, **84**, i, 61, Compt. rend. 1908, **146**, 1405, 1909, **149**, 129, abst J pharm chim 1909, **30**, 153, J. C. S. 1909, **96**, i, 690, Bull Soc Chim 1910, **7**, 394, Chem Zentr 1908, **79**, II, 507; 1909, **80**, II, 684, 1537; Jahr. Chem. 1909, **62**, II, 105, Compt. rend 1917, **164**, 952, abst C. A 1917, **11**, 2661
- 22 Ann Univ. Lyon, New Ser 1901, **6**, I, Ann Chim Phys 1901, **24**, 433; abst J C. S. 1901, **80**, i, 679, Jahr. Chem. 1901, **54**, 597

E. Archibald and D. McIntosh,¹ E. Amagat,² E. Loomis,³ F. Southerk,⁴ C. Jackson and J. Derby,⁵ P. Sabatier and J. Senderens,⁶ W. Sagrebin and N. Menshutkin,⁷ A. Schükarew,⁸ W. 'ipatjeff,⁹ E. Vitoria,¹⁰ E. Orloff,¹¹ G. Oddo and G. Cusmano,¹² P. Paschal,¹³ F. Perkin and L. Pratt,¹⁴ A. Findlay,¹⁵ P. Freundler,¹⁶ F. Courturier and L. Meunier,¹⁷ A. Michael and K. Wolgast,¹⁸ J. Holmes,¹⁹ T. van Hove,²⁰ E. Bosse,²¹ H. Jones,²² G. Carrara and A. Bringhamti,²³ J. Tafel,²⁴ J. Timmermann,²⁵ C. Winther,²⁶ A. Wohl and H. Roth,²⁷ P. Dutoit and H. Duperthuis,²⁸ M. Delacre,²⁹ A. Dun-

1. J. C. S. 1904, **85**, 919; abst. *Jahr. Chem.* 1904, **57**, 805.
2. *Ann. Chim. Phys.* 1893, **29**, 68; abst. *Zts. physik. Chem.* 1900, **32**, 119.
3. *Zts. physik. Chem.* 1900, **32**, 594; abst. J. C. S. 1900, **78**, ii, 335; 1901, **80**, ii, 492.
4. *Proc. Chem. Soc.* 1904, **20**, 117; abst. *Chem. Centr.* 1904, **75**, II, 18; *Chem. News*, 1904, **89**, 260; *Jahr. Chem.* 1904, **57**, 858.
5. *Amer. Chem. J.* 1900, **24**, 15; abst. *Chem. Centr.* 1900, **71**, II, 559.
6. *Compt. rend.* 1903, **137**, 301; abst. *Chem. Centr.* 1903, **74**, II, 708.
7. *J. Russ. Phys. Chem. Soc.* 1899, **31**, 19; abst. J. C. S. 1899, **76**, ii, 735; *Chem. Centr.* 1899, **70**, I, 1059; *Zts. physik. Chem.* 1900, **34**, 151, 152; **32**, 640.
8. *Zts. physik. Chem.* 1903, **44**, 556, 558; abst. J. C. S. 1903, **84**, ii, 710.
9. *J. Russ. Phys. Chem. Soc.* 1904, **36**, 813; abst. *Chem. Centr.* 1904, **75**, II, 1020. See also *Zts. physik. Chem.* 1903, **46**, 117.
10. *Bull. Acad. roy. Belg.* 1904, 1087; abst. J. C. S. 1905, **88**, i, 110.
11. *J. Russ. Phys. Chem. Soc.* 1908, **40**, 203; abst. J. C. S. 1908, **94**, i, 306.
12. *Gaz. chim. ital.* 1905, **35**, I, 46; abst. *Jahr. Chem.* 1905-1908, II, 187; J. C. S. 1905, **94**, i, 402; *Chem. Centr.* 1905, **76**, II, 1215.
13. *Bull. Soc. Chim.* 1909, **5**, 1110; abst. *Jahr. Chem.* 1909, **62**, II, 5.
14. J. C. S. 1909, **95**, 159; abst. *Jahr. Chem.* 1909, **62**, II, 102.
15. J. C. S. 1905, **87**, 819; abst. *Jahr. Chem.* 1905-1908, II, 187; *Chem. Centr.* 1905, **76**, II, 453; *Bull. Soc. Chim.* 1906, **36**, 247. See also S. Pickering, *Ber.* 1891, **24**, 3639; *Nature*, 1897, **55**, 224.
16. *Compt. rend.* 1907, **144**, 272; abst. J. C. S. 1907, **92**, i, 174.
17. *Compt. rend.* 1904, **140**, 721; abst. *Chem. Centr.* 1905, **76**, I, 1133.
18. *Ber.* 1909, **42**, 3157; abst. *Chem. Zentr.* 1909, **80**, II, 1415.
19. *Proc. Chem. Soc.* 1907, **22**, 272; abst. *Bull. Soc. Chim.* 1907, **2**, 565; *Jahr. Chem.* 1905-1908, I, 98.
20. *Bull. Acad. roy. Belg.* 1908, 540; abst. *Jahr. Chem.* 1905-1908, II, 292; *Chem. Zentr.* 1908, **79**, II, 292.
21. *Nachr. K. Akad. Wiss. Goettingen*, 1906, 278; abst. *Chem. Zentr.* 1907, **78**, I, 233; *Jahr. Chem.* 1905-1908, II, 166, 167.
22. *Zts. physik. Chem.* 1906, **56**, 129; abst. *Jahr. Chem.* 1905-1908, I, 642.
23. *Gaz. chim. ital.* 1908, **38**, I, 698; abst. *Chem. Zentr.* 1908, **79**, II, 933.
24. *Ber.* 1906, **39**, 3626; abst. *Chem. Zentr.* 1907, **78**, I, 17.
25. *Zts. physik. Chem.* 1907, **58**, 129; abst. *Chem. Zentr.* 1907, **78**, I, 1008.
26. *Zts. physik. Chem.* 1907, **60**, 590, 641, 685, 756; abst. *Chem. Zentr.* 1908, **79**, I, 97.
27. *Ber.* 1907, **40**, 212; 1908, **41**, 3599; abst. J. C. S. 1907, **92**, i, 170;

stan,¹ A. Doroszewsky,² A. Doroszewsky and M. Roschdestwensky,³ G. Lemoine,⁴ J. Senderens,⁵ P. Sabatier and A. Mailhe,⁶ P. Sabatier,⁷ W. Turner and C. Bissett,⁸ M. Wrewski,⁹ A. Kibler,¹⁰ A. Le Duc,¹¹ A. Doroszewski and E. Polianski,¹² F. Lorenz,¹³ E. Pringsheim,¹⁴ Heffter and Juckenack,¹⁵ G. Just,¹⁶ and F. Usher.¹⁷

Butyl Alcohol. Of four possible isomerides, all are known, the isobutyl alcohol being the body used as a nitrocellulose solvent when esterified, and as a diluent in the free state.

The work on the butyl alcohols before 1870 was, in the main, of an academic character, and of purely theoretical interest. They include the contributions of A. Wurtz,¹⁸ E. Humann,¹⁹ A.

1908, **94**, 1, 942.

28 J. chim. phys. **6**, 609, abst. Chem. Zentr. 1909, **80**, I, 710.

29. Bull. Soc. Chim. 1909, **5**, 884, abst. Chem. Zentr. 1909, **80**, II, 1632.

1. J. C. S. 1905, **87**, 12; abst. Jahr. Chem. 1905-1908, I, 70.

2. J. Russ. Phys. Chem. Soc. 1909, **41**, 958; abst. Jahr. Chem. 1909,

62, II, 95; Chem. Zentr. 1910, **81**, I, 157.

3. J. Russ. Phys. Chem. Soc. 1909, **41**, 1428, abst. Jahr. Chem. 1909,

62, II, 95; Chem. Zentr. 1910, **81**, I, 812; J. C. S. 1910, **98**, i, 85.

4. Compt. rend. 1908, **146**, 1360, abst. Jahr. Chem. 1908, **79**, II, 389,

1675; Bull. Soc. Chim. 1908, **3**, 935; Jahr. Chem. 1905-1908, II, 171. Cf.

Compt. rend. 1907, **144**, 357, abst. Chem. Zentr. 1907, **78**, I, 1246.

5. Bull. Soc. Chim. 1908, **3**, 935, abst. Jahr. Chem. 1905-1908, II,

171. Compt. rend. 1907, **144**, 381, 1909, **148**, 927; abst. Chem. Zentr. 1907,

78, I, 1245; 1909, **80**, I, 1855.

6. Compt. rend. 1907, **146**, 1376, 1908, **147**, 16, 106, abst. Jahr. Chem.

1905-1908, II, 172. Ann. Chim. Phys. 1910, **20**, 303, abst. Chem. Zentr.

1910, **82**, II, 1136.

7. Compt. rend. 1907, **144**, 879, abst. Jahr. Chem. 1905-1908, II, 204.

8. J. C. S. 1913, **103**, 1904, abst. J. S. C. I. 1913, **32**, 1134.

9. J. Russ. Phys. Chem. Soc. 1910, **42**, 1, abst. Jahr. Chem. 1910, **63**,

II, 87.

10. Eighth Inter. Cong. Appl. Chem. Appendix **25**, 239, abst. C. A.

1913, **7**, 2117.

11. Compt. rend. 1912, **155**, 206; abst. J. C. S. 1912, **102**, ii, 831.

12. J. Russ. Phys. Chem. Soc. 1910, **42**, 109, 1448; abst. J. C. S. 1911,

100, i, 253; Bull. Soc. Chim. 1911, **10**, 1284; Chem. Zentr. 1911, **82**, I, 465,

1226; Jahr. Chem. 1910, **63**, II, 89.

13. Ann. Soc. Espan. Ph. Ch. 1914, **12**, 236; Bull. Soc. Chim. 1914, **16**,

631; J. S. C. I. 1914, **33**, 1223.

14. Zts. physik. Chem. 1889, **3**, 153, abst. J. C. S. 1889, **56**, 672.

15. Vrtljschr. f. Ger. Med. u. öffentk. Sanitätswesen, 1919, (3), **58**, 1;

abst. J. S. C. I. 1919, **38**, 924-A.

16. Zts. physik. Chem. 1901, **37**, 354. See also Zts. Spiritusind. **33**, 537.

17. J. C. S. 1910, **97**, 72; abst. Chem. Zentr. 1910, **82**, I, 1007.

18. Compt. rend. 1852, **35**, 310; 1854, **39**, 335; 1862, **55**, 370; Ann.

Chim. Phys. 1854, **42**, 129; Ann. 1853, **85**, 197; 1855, **93**, 107; Suppl. **1**, 380;

Chem. Centr. 1851, **22**, 798; 1854, **25**, 727; 1861, **32**, 641; Rep. Chim. Pure,

1862, **4**, 120; Jahr. Chem. 1854, **7**, 568; J. prakt. Chem. 1855, **64**, 282;

1854, **63**, 68.

19. Ann. Chim. Phys. 1855, **44**, 337; J. prakt. Chem. 1856, **67**, 37;

Chem. Centr. 1855, **26**, 783.

Schöyn,¹ C. Michaelson,² V. de Luynes,³ A. Siersch,⁴ A. Lieben and A. Rossi,⁵ A. Lieben,⁶ E. Chapman and M. Smith,⁷ E. Erlenmeyer,⁸ A. Butlerow,⁹ E. Schmidt,¹⁰ A. Saytzeff,¹¹ A. Natmann,¹² E. Mylius,¹³ W. Morownikoff,¹⁴ J. Konnonikoff and A. Saytzeff,¹⁵

1. Ann. 1864, **130**, 233, Chem. Centr. 1864, **35**, 1037; Ann. Chim. Phys. 1864, **2**, 490; Bull. Soc. Chim. 1864, **2**, 364, J. pharm. chim. 1864, **46**, 68, Phil. Mag. 1865, **29**, 308, Jahr. Chem. 1864, **17**, 334.

2. Compt. rend. 1864, **59**, 388, 442, Instit. 1864, 276; Ann. 1865, **133**, 182; abst. Chem. Centr. 1865, **36**, 302, 337, Jahr. Chem. 1864, **17**, 336; J. prakt. Chem. 1864, **93**, 126, 1865, **94**, 50; Zts. Chem. 1864, **7**, 571, 573, Phil. Mag. 1865, **29**, 309.

3. Compt. rend. 1863, **56**, 803, abst. Rep. Chim. Pure, 1863, **5**, 469, 578; Chem. Centr. 1863, **34**, 691.

4. Ann. 1868, **148**, 261, Zts. Chem. 1869, **12**, 145, abst. Jahr. Chem. 1868, **21**, 436, Bull. Soc. Chim. 1869, **12**, 274, Ann. Chim. Phys. 1869, **17**, 436.

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8. Ann. 1867, Suppl. **5**, 337, abst. J. C. S. 1871, **24**, 125, Ber. 1870, **3**, 897, 899; Chem. Centr. 1868, **39**, 361, 1870, **41**, 802, Jahr. Chem. 1870, **23**, 656, 667, Zts. Chem. 1867, **10**, 117.

9. Ann. 1867, **144**, 1, 1873, **168**, 113, **170**, 211, 1876, **180**, 245, abst. Bull. Soc. Chim. 1865, **2**, 106, 1866, **5**, 17, 1867, **8**, 186, 1876, **25**, 294, 1877, **27**, 533, **28**, 110, Ber. 1871, **4**, 931, 1876, **9**, 1687; 1877, **10**, 81, Chem. Centr. 1865, **36**, 168, 1866, **37**, 273, 1867, **38**, 353, 361, 1868, **39**, 353, 1870, **41**, 306, 1872, **43**, 2, 100, 1877, **48**, 164, Gaz. chim. ital. 1876, **6**, 523; Jahr. Chem. 1864, **17**, 496, 1865, **18**, 560, 1867, **20**, 575, 1871, **24**, 374; 1875, **28**, 265; 1876, **29**, 355, 1874, **27**, 322, 332, 1877, **30**, 533, J. prakt. Chem. 1875, **119**, 229; Zts. Chem. 1864, **7**, 385, 702; 1865, **8**, 614, 1867, **10**, 361, 680, 1870, **13**, 236, 1871, **14**, 484, N. Petersb. Acad. Bull. **18**, 505. See also Ann. 1878, **190**, 331.

10. Tageblatt d. Naturf.-Vers. Breslau, 1874, 79, abst. Chem. Centr. 1874, **45**, 642, Ber. 1874, **7**, 755.

11. J. prakt. Chem. 1871, **111**, 82, abst. Bull. Soc. Chim. 1870, **14**, 51, Chem. Centr. 1870, **41**, 420; Jahr. Chem. 1870, **23**, 420, 485; Zts. Chem. 1870, **13**, 105, 327, Amer. J. Sci. 1870, (2), **50**, 417.

12. Ber. 1871, **7**, 173, abst. J. C. S. 1874, **27**, 529; Jahr. Chem. 1874, **27**, 16.

13. Ber. 1873, **6**, 312; abst. Jahr. Chem. 1872, **25**, 485, 1873, **26**, 527; Chem. Centr. 1873, **44**, 35.

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15. Ann. 1875, **175**, 374; abst. Jahr. Chem. 1874, **27**, 347; 1875, **28**, 272; Ber. 1874, **7**, 1650; Bull. Soc. Chim. 1874, **22**, 546; Chem. Centr. 1875, **46**, 50.

G. Barbaglia,¹ N. Grabowsky and A. Saytzeff,² A. Hoffmann,³ G. Kraemer and A. Pinner,⁴ and G. Kraemer.⁵

The score of years embracing 1871-1890 saw many noteworthy advances in elucidation of the structure of these isomeric bodies, and pointing out possible uses for them in the arts. These ideas and discoveries are comprehended in the writings of G. Wagner,⁶ E. Wagner,⁷ S. Pagliani,⁸ J. Pierre and E. Puchot,⁹ D. Pawlow,¹⁰ M. Novole,¹¹ V. Meyer, J. Barbieri and F. Forster,¹² A. Lieben and S. Zeisel,¹³ J. Le Bel and W. Greene,¹⁴ P. Lohmann,¹⁵ A. Freund,¹⁶ A. Fitz,¹⁷ P. Behrend,¹⁸ A. Vigna,¹⁹ A. Studer,²⁰ F.

¹ Ber 1873, **6**, 910, abst J C S 1873, **26**, 877, Chem Centr 1873, **44**, 578

² Ann 1874, **171**, 251, Ber 1873, **6**, 1256, abst Chem Centr 1873, **44**, 802, 1874, **45**, 322, Jahr Chem 1874, **27**, 344, Bull Soc Chim 1874, **22**, 546

³ Ber 1874, **7**, 508, abst Bull Soc Chim 1874, **22**, 364, Jahr Chem 1874, **27**, 340

⁴ Ber 1870, **3**, 75, Zts Chem 1870, **13**, 470, abst Jahr Chem 1870, **23**, 423, Bull Soc Chim 1871, **16**, 274, Chem Centr 1870, **41**, 131

⁵ Ber 1873, **6**, 1120, 1874, **7**, 252, abst Bull Soc Chim 1874, **22**, 180, Chem Centr 1873, **44**, 674, 1874, **45**, 278, Jahr Chem 1874, **29**, 315, 1873, **26**, 471. See also Ann 1870, Suppl **7**, 218, abst Chem Centr 1870, **41**, 323

⁶ Petersb Acad Bull **21**, 366, Ann 1876, **181**, 261, Bull Soc Chim 1876, **25**, 293, Jahr Chem 1876, **29**, 314

⁷ Ber 1875, **8**, 1682, abst Chem Centr 1876, **47**, 116, Jahr Chem 1875, **28**, 272

⁸ Ber 1877, **10**, 2055, abst J C S 1878, **34**, 287, 653, Jahr Chem 1877, **30**, 603

⁹ Compt rend 1867, **64**, 302, abst Zts Chem 1868, **11**, 351, Chem. Centr 1868, **39**, 989, Jahr Chem 1868, **21**, 434

¹⁰ N Petersb Acad Bull **22**, 497, Ann 1877, **188**, 118, abst Jahr Chem 1877, **30**, 531, 869

¹¹ Bull Soc Chim 1875, **24**, 97, 122, abst Ber 1875, **8**, 983, Chem Centr 1875, **46**, 581

¹² Ber 1877, **10**, 130, abst Chem Centr 1877, **48**, 211, Jahr Chem 1877, **30**, 435

¹³ Ber 1879, **12**, 570, abst J C S 1879, **36**, 615, Jahr Chem 1879, **32**, 551

¹⁴ Compt rend 1879, **89**, 413, Ber 1879, **12**, 2262, abst Bull Soc Chim 1881, **35**, 438, Jahr Chem 1879, **32**, 489

¹⁵ Ber 1878, **11**, 1485, abst Chem Centr 1878, **49**, 691, Jahr Chem 1878, **31**, 340

¹⁶ J prakt Chem 1875, **120**, 25, abst J C S 1876, **29**, 543, Jahr Chem 1875, **28**, 272

¹⁷ Ber 1876, **9**, 1348, 1880, **13**, 1311, Bull Soc Chim 1877, **28**, 24, 1878, **29**, 472, Jahr Chem 1876, **29**, 343, 1877, **30**, 1019, 1880, **33**, 605, Chem Centr 1876, **47**, 787

¹⁸ Ber 1876, **9**, 1334, abst Chem Centr 1876, **47**, 770, 771, Jahr. Chem 1876, **29**, 330; J C S 1876, **30**, 878, J prakt Chem 1877, **123**, 34.

¹⁹ Gaz chim ital 1883, **13**, 293, Ber 1883, **16**, 1438, abst. Jahr. Chem. 1883, **36**, 1501

²⁰ Ber. 1881, **14**, 2074, abst Jahr Chem 1881, **34**, 459. See also K. Zalessky, Ber. 1872, **5**, 480.

Raoult,⁴ E. Puchot,² B. Pawleski,³ T. Poleck and I. Samelson,⁴ V. Merz and K. Gasiorowski,⁵ W. Alexejeff,⁶ G. Bertoni and F. Truffi,⁷ J. Effront,⁸ A. Gorbhoff and A. Kessler,⁹ H. Goldsmith,¹⁰ D. Konowaloff,¹¹ A. Ditte,¹² L. Dobbin,¹³ C. Willgerodt and A. Genieser,¹⁴ V. Tiscenko,¹⁵ H. Thierfelder and J. von Mering,¹⁶ M. Scheschukow,¹⁷ F. Stohmann,¹⁸ F. Schnauffer and H. Hupfeld,¹⁹ M. Planck,²⁰ E. Pfingsheim,²¹ H. Malbot and L. Gentil,²² N. Men-

1. Compt. rend. 1883, **96**, 560, 1653, **97**, 825, 941; abst. Jahr. Chem. 1882, **35**, 71; 1883, **36**, 83. Zts physik. Chem. 1887, **1**, 634.

2. Ann. Chim. Phys. 1883, **28**, 508, abst. J. C. S. 1884, **46**, 166; Jahr. Chem. 1883, **36**, 514.

3. Ber. 1882, **15**, 3034; abst. Jahr. Chem. 1882, **35**, 652; Chem. Centr. 1883, **54**, 134. Zts physik. Chem. 1891, **7**, 605.

4. Chem. Centr. 1884, **55**, 813; abst. J. C. S. 1885, **48**, 669; Jahr. Chem. 1884, **37**, 1447.

5. Ber. 1884, **17**, 623; abst. J. C. S. 1884, **46**, 984; Jahr. Chem. 1884, **37**, 906.

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8. Ber. 1884, **17**, 419, 2317; abst. J. C. S. 1884, **46**, 899, Jahr. Chem. 1884, **37**, 734.

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12. Compt. rend. 1880, **91**, 576, abst. Chem. Centr. 1880, **51**, 722, J. C. S. 1881, **40**, 17.

13. J. C. S. 1880, **37**, 236, 245; abst. Jahr. Chem. 1882, **35**, 476. See also Neuste. Erfind. Erfahr. 1882, **9**, 417.

14. J. prakt. Chem. 1888, **145**, 345; abst. Ber. 1888, **21**, 401-R; Jahr. Chem. 1888, **41**, 1571, 1572.

15. J. Russ. Phys. Chem. Soc. 1887, **19**, I, 483; abst. Chem. Centr. 1887, **68**, 1541.

16. Zts. physiol. Chem. **9**, 511; abst. Jahr. Chem. 1885, **38**, 1843; J. C. S. 1885, **48**, 1002.

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22. Compt. rend. 1889, **108**, 957; abst. Chem. Centr. 1889, **60**, I, 781.

schutkin,¹ W. Luginin,² J. Kablukoff,³ A. Bauer,⁴ A. Bonz,⁵ E. Conrady,⁶ M. Claudin,⁷ S. Henrichsen,⁸ J. Habermann,⁹ Bugaieff and A. Wolkoff,¹⁰ S. Arrhenius,¹¹ A. Zander,¹² F. Valentiner,¹³ J. Thomsen,¹⁴ G. Tamann,¹⁵ G. Schmidt,¹⁶ C. Schall,¹⁷ O. Schönrock,¹⁸ Fabriques de Produits Chimiques de Thann et Mulhouse,¹⁹ W. Ramsay and J. Shields,²⁰ W. Röntgen and L. Zehnder,²¹ A. Richardson,²² E. Paterno,²³ A. Nadeschdin,²⁴ A. Nacari and S. Pagliani,²⁵ G. Link and R. Avenarius,²⁶ H. Landolt and H. Jahn,²⁷ J.

1. Zts. physik. Chem. 1887, **1**, 612, 613, 617, 628; 1892, **9**, 237; 1899, **28**, 677; 1900, **34**, 154; 1905, **50**, 60.
2. Compt. rend. 1885, **101**, 1154; abst. Chem. Centr. 1886, **57**, 50; Zts. physik. Chem. 1890, **6**, 339, 1895, **17**, 176; **18**, 511; Compt. rend. 1894, **119**, 601, 645.
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4. E. P. 4963, 1889; 13613, 1891; 17703, 1893; 17781, 1893. See also D. R. P. 47599, 62362, 72998, 77209, 80158, 84336, 86447, 87130, 90291, 94019, 99256. E. P. 12980, 1894; 20521, 1894, 10946, 1895; 15762, 1895; 28467, 1897; 14552, 1896. F. P. 195360, 215355. U. S. P. 412545, 416710, 451847, 481685, 536324, 546086, 559783, 560771, 602961.
5. Zts. physik. Chem. 1888, **2**, 895, abst. J. C. S. 1889, **56**, 335.
6. Zts. physik. Chem. 1889, **3**, 216, abst. J. C. S. 1889, **56**, 661.
7. Mon. Ind. **14**, 146, Sucr. **29**, 568.
8. Zts. physik. Chem. 1888, **2**, 548, Wied. Ann. Phys. 1888, **34**, 548.
9. Monatsh. 1886, **7**, 529, abst. Chem. Centr. 1886, **57**, 866; Bull. Soc. Chim. 1887, **47**, 554; Jahr. Chem. 1886, **39**, 278.
10. Ber. 1885, **18**, 610, abst. Jahr. Chem. 1885, **38**, 1176; Bull. Soc. Chim. 1886, **45**, 249, abst. Jahr. Chem. 1886, **39**, 1174.
11. Zts. physik. Chem. 1887, **1**, 289, 290; 1888, **2**, 495; 1892, **9**, 489, 505.
12. Ann. 1884, **224**, 80; abst. Zts. physik. Chem. 1893, **12**, 468.
13. E. P. 15687, 1890, abst. J. S. C. I. 1890, 997, 1891, **10**, 404, 571, 746, 944; 1892, **11**, 307.
14. See F. Stohmann, Zts. physik. Chem. 1890, **6**, 339, abst. J. C. S. 1891, **60**, 251.
15. Zts. physik. Chem. 1892, **9**, 108; abst. J. C. S. 1892, **62**, 556.
16. Zts. physik. Chem. 1891, **8**, 638; abst. J. C. S. 1891, **60**, 969; 1892, **62**, 396.
17. Zts. physik. Chem. 1894, **14**, 707; abst. J. C. S. 1894, **66**, ii, 439.
18. Zts. physik. Chem. 1893, **11**, 759. Cf. H. Landolt and H. Jahn, J. C. S. 1893, **64**, ii, 57.
19. E. P. 20521, 1894; abst. J. S. C. I. 1895, **14**, 885. E. P. 14552, 1896; 28467, 1897; D. R. P. 99256. E. P. 15762, 1895; abst. J. S. C. I. 1896, **15**, 671. F. P. 195360; D. R. P. 89291. E. P. 12980, 1894; abst. J. S. C. I. 1895, **14**, 595.
20. Zts. physik. Chem. 1893, **12**, 468; abst. J. C. S. 1893, **63**, 1089; 1894, **66**, ii, 179.
21. Wied. Ann. Phys. 1891, **44**, 1, 24; abst. Zts. physik. Chem. 1892, **9**, 226.
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23. Gaz. chim. ital. 1889, **19**, 44; abst. Zts. physik. Chem. 1890, **5**, 94.
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26. E. P. 48, 1891; abst. J. S. C. I. 1891, **10**, 571.
27. Zts. physik. Chem. 1892, **10**, 317; abst. J. C. S. 1893, **64**, ii, 57; Ber. 1892, **25**, 840-R.

Bruhl,¹ M. Beijerink,² J. Eijkmann,³ P. de Heen,⁴ E. Harnak and H. Meyer,⁵ H. Jahn and G. Möller,⁶ L. Kossakowsky,⁷ R. Gartenmeister,⁸ A. Guye,⁹ J. van't Hoff,¹⁰ and C. Guldberg.¹¹

Coincidental with the recognition of the value of amyl alcohol as a nitrocotton solvent when acetated was manifested increased interest in butyl alcohol. During the double decade 1891-1910 its position as a pyroxylin solvent was firmly established. Our sum total of information as issued during this period is indicated from the publications of P. Zuboff,¹² W. Spring,¹³ C. Schmid,¹⁴ Schwarz,¹⁵ P. Subow,¹⁶ R. Nasini,¹⁷ W. Mallmann,¹⁸ K. Arndt,¹⁹ R. Abegg and W. Seitz,²⁰ S. Bigelow,²¹ W. Biltz,²² A. Blaile,²³ M. Dinesman,²⁴ G. Denigés,²⁵ P. Drude,²⁶ Gretsche & Mayer,²⁷

1. Zts. physik. Chem. 1891, **7**, 153, 159, abst J C S 1891, **60**, 774
2. Verhandel Koninkl Akad Wiss Amsterdam, Sect II, I, No. 10; abst. Centr. Bact. Parasitenkunde, **15**, 171, Chem. Centr. 1894, **65**, I, 963, Rec. trav. Chim. Pays-Bas, 1893, **12**, 141; Jahr. Chem. 1894, **47**, 771; Zts. Spiritusind. **17**, 233
3. Rec. trav. Chim. Pays-Bas, 1893, **12**, 164, 278, abst Chem. Centr. 1893, **64**, II, 900, Jahr. Chem. 1893, **46**, 41, Bull. Soc. Chim. 1893, **10**, 419
4. Recherch. la physique, Paris, 1888, 102, abst Zts. physik. Chem. 1891, **7**, 605
5. Zts. Klin. Med. **24**, 374, abst Chem. Centr. 1894, **65**, I, 514
6. Zts. physik. Chem. 1894, **13**, 396, abst J C S 1894, **66**, ii, 265
7. Zts. physik. Chem. 1891, **8**, 171, 268, abst Ber. 1891, **24**, 613-R.
8. Zts. physik. Chem. 1890, **6**, 532, abst J C S 1891, **60**, 380.
9. Compt. rend. 1890, **110**, 141, abst Zts. physik. Chem. 1890, **5**, 276.
10. See E. Euler, Zts. physik. Chem. 1901, **36**, 656.
11. Zts. physik. Chem. 1890, **5**, 374, 1891, **7**, 605, 1900, **32**, 124.
12. J. Russ. Phys. Chem. Soc. 1898, **30**, 926, abst. Jahr. Chem. 1898, **51**, 111.
13. Rec. trav. Chim. Pays-Bas, 1897, **16**, I, abst. Zts. physik. Chem. 1898, **27**, 177.
14. Belg. P. 127545, 1897
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16. J. Russ. Phys. Chem. Soc. 1898, **30**, 926, abst. Zts. physik. Chem. 1899, **29**, 759
17. Gaz. chim. ital. 1893, **23**, II, 37; abst. Zts. physik. Chem. 1895, **16**, 248.
18. E. P. 4018, 1894, 417, 1895, abst. J. S. C. I. 1894, **13**, 303, 570, 659; 1895, **14**, 100, 218, 385.
19. Dissertation, Basle, 1897, **128**, abst. Zts. physik. Chem. 1898, **26**, 372.
20. Zts. physik. Chem. 1899, **29**, 245; abst. J. C. S. 1899, **76**, ii, 623.
21. Zts. physik. Chem. 1898, **26**, 528, abst. J. C. S. 1898, **74**, ii, 506.
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23. E. P. 24568, 1896; abst. Chem. Ztg. 1898, **22**, 285; Mon. Sci. 1898, **52**, 183.
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G. Kahlbaum and K. Arndt,¹ H. Beckmann, V. Gernhardt and G. Fuchs,² J. Kuenen and W. Robson,³ J. von Kowalski,⁴ C. Gluecksmann,⁵ S. Young and C. Fortey,⁶ A. Trillat,⁷ B. Turner,⁸ L. Servais,⁹ W. Sagrebin,¹⁰ R. von Stepski,¹¹ G. Poncio,¹² G. Perrier and I. Pouget,¹³ T. Patterson,¹⁴ J. Norris and E. Green,¹⁵ J. Norris,¹⁶ E. Loomis,¹⁷ A. Lederer,¹⁸ T. Aldrich and C. Beckwith,¹⁹ E. Boedtker,²⁰ G. Carrara and A. Coppadoro,²¹ G. Ferrari,²² M. Guerbet,²³ V. Grignard,²⁴ L. Tissier and V. Grignard,²⁵ L. Gony,²⁶

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26 Zts physik Chem 1897, **23**, 309, 1898, **26**, 190, 1899, **28**, 678

27 E. P. 9521, 1896, abst Chem Ztg 1897, **21**, 878, Mon Sci 1898, **52**, 110.

1. Zts physik Chem 1898, **26**, 646, abst Chem Centr 1898, **69**, II, 620.

2. Zts physik Chem 1895, **18**, 483, 502, abst J C S 1896, **70**, n, 236

3. Zts physik Chem 1899, **28**, 363, abst J C S 1899, **76**, n, 356

4. Compt rend 1894, **119**, 512, abst Zts physik Chem 1895, **17**, 174

5. Monatsh 1895, **16**, 897, abst Chem Centr 1895, **66**, I, 691 See also Belg P. 125948, 127545, 184417

6 J C S 1902, **81**, 717, 739, abst Zts physik Chem 1903, **43**, 122, 124

7 Compt rend 1901, **132**, 1495, abst Jahr Chem 1901, **54**, 607

8 Zts physik Chem 1900, **35**, 403, 428, abst J C S 1901, **80**, n, 53

9 Bull Acad roy Belg 1900, 695, abst Chem Centr 1901, **72**, I, 93

10 J. Russ. Phys. Chem. Soc 1899, **31**, 19, abst Zts physik Chem 1900, **32**, 151, 632, 640

11. Wien Akad. Ber **111**, II-b, 577, Monatsh. 1902, **23**, 773, abst Jahr Chem 1902, **55**, 740, J C S 1903, **84**, i, 61

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13 Bull Soc Chim 1901, **25**, 551, abst J C S 1901, **80**, i, 442, Jahr Chem 1901, **54**, 608, Chem Centr 1901, **72**, II, 25

14. J. C S 1901, **79**, 167, 477, abst Zts physik Chem 1902, **40**, 510

15 Amer Chem J. 1901, **26**, 293, 1902, **27**, 306, abst Jahr Chem 1901, **54**, 616, Chem Centr 1901, **72**, II, 1113

16 Amer Chem J 1907, **38**, 627, abst Jahr Chem 1905 1908, II, 2655.

17. Zts physik Chem 1900, **32**, 595, abst J C S 1900, **78**, n, 335, 1901, **80**, ii, 492

18 Wien Akad. Ber **110**, II-b, 438, Monatsh 1901, **22**, 536, abst Jahr Chem 1901, **54**, 805, Chem Centr 1901, **72**, II, 762, Bull Soc Chim 1902, **28**, 825.

19. U S. P. 777712, 1904, abst J. A. C. S 1905, **27R**, 501, Mon Sci 1905, **63**, 119 J. A. C. S. 1916, **38**, 2740, abst J C S I 1917, **36**, 100 J. A. C. S 1918, **40**, 1948, abst C A 1919, **13**, 312

20. Bull. Soc. Chim. 1904, **31**, 965, abst. Jahr. Chem 1904, **57**, 1275

21. Mem. R. Acad. Lincei, 1901, 317, abst Zts physik Chem 1903, **44**, 380.

22. Mem. R. Acad. Lincei, 1901, 317; abst. Zts physik Chem 1903, **44**, 380.

23. Compt. rend, 1899, **128**, 511, 1002, 1901, **132**, 207, 685, **133**, 300, 1220; 1908, **146**, 1405; 1910, **150**, 183; Bull. Soc Chim 1902, **27**, 578, 581, J. pharm. chim. 1901, **14**, 246; abst. J. C. S. 1910, **98**, i, 149, Chem Centr. 1899, **70**, I, 728, 1103; 1901, **72**, I, 502, 728; II, 621, 1902, **73**, II, 339, 340; 1908, **79**, II, 507; Jahr. Chem. 1901, **54**, 615, 619.

24. Compt. rend. 1903, **136**, 1260, abst Chem. Centr 1903, **74**, II, 105;

A. Goldberg and M. Zimmermann,¹ J. Guinchant,² C. Holley,³ G. Heinrich,⁴ E. Houghton and T. Aldrich,⁵ and G. Just.⁶

From 1911 to the present, perhaps the most important and far-reaching series of investigations have been in connection with the production of normal butyl alcohol by fermentation, in which acetone is also obtained in roughly one-half the amount. The advancements during this period will be found in the disclosures of C. Vallee,⁷ F. Schardinger,⁸ P. Sabatier and A. Maihle,⁹ E. de Stoecklin,¹⁰ J. Riche,¹¹ E. Paterno and A. Mielli,¹² E. Orloff,¹³ R. Meth,¹⁴ A. Michael and R. Brunel,¹⁵ A. Michael and P. Cobb,¹⁶ A. Michael,¹⁷ Akt.-Ges. f. Anilinfabrikation,¹⁸ E. Abderhalden, W. Weichardt, H. Dean, P. Hirsch, J. Schuler and G. Brossa,¹⁹ A.

Jahr. Chem. 1903, **56**, 1104; Bull. Soc. Chim. 1903, **29**, 994.

25. Compt. rend. 1901, **132**, 683; 1902, **134**, 107; abst. Jahr. Chem. 1901, **54**, 986; J. S. C. I. 1902, **21**, 286.

26. Compt. rend. 1901, **132**, 822; **133**, 1301; abst. Jahr. Chem. 1901, **54**, 97; J. C. S. 1901, **80**, ii, 435; Zts. physik. Chem. 1902, **47**, 753.

1. Zts. ang. Chem. 1902, **15**, 808; abst. Jahr. Chem. 1902, **55**, 971.

2. Compt. rend. 1901, **132**, 469; abst. Jahr. Chem. 1901, **54**, 26; J. C. S. 1901, **80**, ii, 227.

3. J. A. C. S. 1902, **24**, 448; abst. Zts. physik. Chem. 1903, **42**, 510.

4. Sitzber. Bayer. Akad. 1900, **30**, 35; abst. Zts. physik. Chem. 1901, **37**, 227.

5. Proc. Amer. Physiol. Soc. 1902, **18**, No. 19; Amer. J. Physiol. **8**; abst. J. C. S. 1903, **84**, ii, 315.

6. Zts. physik. Chem. 1901, **37**, 354; abst. J. C. S. 1901, **80**, ii, 439.

7. Ann. Chim. Phys. 1908, **15**, 331; abst. J. C. S. 1908, **94**, i, 976.

8. Zentr. Bact. Parasitenkunde, **2**, Abt. 18, 748; abst. Chem. Zentr. 1907, **78**, II, 271.

9. Compt. rend. 1908, **147**, 106; abst. Chem. Zentr. 1908, **79**, II, 675.

10. Compt. rend. 1909, **148**, 424; abst. Jahr. Chem. 1909, **62**, II, 96.

11. J. pharm. chim. 1909, **29**, 57; abst. Chem. Zentr. 1909, **80**, I, 753; Jahr. Chem. 1909, **62**, II, 103.

12. Gaz. chim. ital. 1908, **38**, II, 137, 330; Accad. Lincei Rend. (5), **16**, II, 153; **17**, I, 396; abst. Jahr. Chem. 1905-1908, II, 189, 190; J. C. S. 1907, **92**, i, 815; 1908, **94**, i, 383; Chem. Zentr. 1908, **79**, I, 1930; II, 1161.

13. J. Russ. Phys. Chem. Soc. 1908, **40**, 203; abst. J. C. S. 1908, **94**, i, 306.

14. Ber. 1907, **40**, 695; abst. J. S. C. I. 1907, **26**, 279; Jahr. Chem. 1905-1908, II, 189; Chem. Zentr. 1907, **78**, I, 942; J. C. S. 1907, **92**, i, 272.

15. Amer. Chem. J. 1909, **41**, 118; abst. Jahr. Chem. 1909, **62**, II, 59.

16. Ann. 1908, **363**, 64; abst. Jahr. Chem. 1905-1908, II, 1705.

17. Ber. 1905, **38**, 3217; abst. Chem. Centr. 1905, **76**, II, 1665.

18. F. P. 372603, 1906; E. P. 28147, 1906; abst. J. S. C. I. 1907, **26**, 638, 759. D. R. P. 184230, 1906; abst. Jahr. Chem. 1905-1908, II, 1442; Wag. Jahr. 1907, **53**, II, 27; Zts. ang. Chem. 1908, **21**, 219; Chem. Ind. 1907, **30**, 256; Chem. Zentr. 1907, **78**, II, 366; Chem. Ztg. 1907, **31**, 193.

19. Zts. physiol. Chem. 1909, **59**, 170, 174; **63**, 401; abst. J. C. S. 1909, **96**, i, 800, 903; J. S. C. I. 1909, **28**, 240, 518; 1910, **29**, 146; Ber. 1909, **42**, 3394, 3411; Chem. Zentr. 1909, **80**, I, 1662; II, 1457, 1545; 1910, **81**, I, 31; Jahr. Chem. 1909, **62**, I, 413; II, 761, 1482, 1483, 1542, 1544.

Bourguignone,¹ E. Buchner and J. Meisenheimer,² Farbenf. vorm. F. Bayer & Co.,³ E. Bose and B. Clark,⁴ I. Clarke,⁵ G. du Pont,⁶ W. Dolgolenko,⁷ H. Fournier,⁸ E. Ferrario and F. Fagetti,⁹ L. Henry,¹⁰ W. Ipatjew,¹¹ S. Zeisel and M. Daniel,¹² R. Wolfenstein,¹³ F. Schweser,¹⁴ W. Perkin and F. Matthews,¹⁵ R. Pickard and J. Kenyon,¹⁶ A. Lassere,¹⁷ A. Kling,¹⁸ W. Atkins,¹⁹ A. Bertrath,²⁰ E. I. duPont de Nemours Powder Co.,²¹ A. Fernbach and E. Strange,²² T. von Fellenberg,²³ J. Reilly and E. Ralph,²⁴ K. Orton and D.

1. Bull. Soc. chim. Belg **22**, 87, abst. J. C. S. 1908, **94**, i, 280, Chem. Zentr. 1908, **79**, i, 1630.
2. Ber. 1908, **41**, 1410, abst. Chem. Zentr. 1908, **79**, i, 1986, Jahr. Chem. 1905-1908, II, 367; J. C. S. 1908, **94**, II, 525, Bull. Soc. Chim. 1909, **6**, 941.
3. E. P. 17928, 1909, abst. J. S. C. I. 1910, **29**, 650. D. R. P. 289687, 1914; abst. J. S. C. I. 1916, **35**, 613.
4. Physik. Zts. 1907, **8**, 951; abst. Chem. Zentr. 1908, **79**, i, 588.
5. Amer. Chem. J. 1908, **39**, 572; abst. Jahr. Chem. 1905-1908, II, 84; Chem. Zentr. 1908, **79**, II, 30, Bull. Soc. Chim. 1909, **6**, 808, J. C. S. 1908, **94**, i, 493.
6. Compt. rend. 1909, **148**, 1522, abst. C. A. 1909, **3**, 2674, Jahr. Chem. 1909, **62**, II, 63, Chem. Zentr. 1909, **80**, II, 181, Bull. Soc. Chim. 1910, **7**, 78; J. C. S. 1909, **96**, i, 545.
7. J. Russ. Phys. Chem. Soc. 1907, **39**, 841, abst. Chem. Zentr. 1908, **79**, i, 322.
8. Compt. rend. 1907, **144**, 331, abst. Chem. Zentr. 1907, **78**, i, 1179, Bull. Soc. Chim. 1907, **1**, 506, J. C. S. 1907, **92**, i, 271, Jahr. Chem. 1905-1908, II, 368.
9. Gaz. chim. ital. 1908, **38**, II, 630, abst. Chem. Zentr. 1909, **80**, I, 436; J. C. S. 1909, **96**, i, 77, Bull. Soc. Chim. 1910, **8**, 153.
10. Compt. rend. 1906, **142**, 193, 1907, **145**, 154, 198, 899, abst. J. C. S. 1906, **90**, i, 228, Bull. Soc. Chim. 1907, **1**, 1148, 1149, Chem. Zentr. 1907, **78**, II, 1054, 1059, 1189, Jahr. Chem. 1905-1908, II, 190.
11. J. Russ. Phys. Chem. Soc. 1908, **40**, 511, abst. Chem. Zentr. 1908, **79**, II, 1099.
12. Wien. Akad. Ber. **118**, II-b, 527, Monatsh. 1909, **30**, 727, abst. Jahr. Chem. 1909, **62**, II, 313, J. C. S. 1910, **98**, i, 92.
13. U. S. P. 1072289, 1913, abst. C. A. 1913, **7**, 3531, Chem. Ztg. Rep. 1914, **38**, 143.
14. J. C. S. 1912, **101**, 1891; abst. C. A. 1913, **7**, 1659.
15. E. P. 17235, 1911; abst. J. S. C. I. 1913, **32**, 884, Chem. Ztg. Rep. 1913, **7**, 644.
16. J. C. S. 1912, **101**, 624, 626, 637; abst. C. A. 1913, **7**, 3755.
17. Ann. Chim. anal. 1910, **15**, 338; abst. J. C. S. 1910, **98**, ii, 1005.
18. Compt. rend. 1911, **152**, 702; Bull. Soc. Chim. 1911, **9**, 278, abst. Chem. Zentr. 1911, **82**, i, 1271.
19. J. C. S. 1911, **99**, 10; abst. Chem. Zentr. 1911, **82**, i, 799.
20. Ann. 1911, **382**, 235; abst. J. C. S. 1911, **100**, ii, 681; Chem. Zentr. 1911, **82**, II, 584; Bull. Soc. Chim. 1911, **10**, 830.
21. U. S. P. 1008333; E. P. 17259, 1911; abst. J. S. C. I. 1911, **30**, 1410; 1912, **31**, 257; C. A. 1913, **7**, 417. E. P. 133972, 1910; abst. C. A. 1920, **14**, 840.
22. E. P. 16925, 1911; abst. J. S. C. I. 1912, **31**, 1143; C. A. 1913, **7**, 396.
23. Mitt. Lebensm. u. Hyg. **1**, 352; abst. Chem. Zentr. 1911, **82**, i, 1255; J. C. S. 1911, **100**, ii, 667. See also K. Micko, Zts. Nahr.

Jones,¹ E. Flaherty,² A. Gill,³ R. Adams and C. Marvel,⁴ O. Rosenheim,⁵ C. Weizmann and D Legg,⁶ T. Newmann,⁷ and M. Pardee, R. Hasche and E. Reid.⁸

Amyl Alcohol. The largest portion of, and the most important constituent in, fusel oil is amyl alcohol, of which eight isomers are possible, and all known. Not only is amyl alcohol of importance as an important resin and varnish solvent and desirable diluent in pyroxylin lacquers, but as a source for the manufacture of amyl acetate.

In the period before 1850 appeared the investigations of F. Körte,⁹ J. Schrader,¹⁰ H. Kopp,¹¹ J. Ebelmen,¹² T. Rieckher,¹³ J. Reynolds,¹⁴ H. Medlock¹⁵ and I. Pierre,¹⁶ which, together with the writings of S. Johnson,¹⁷ W. Delffs,¹⁸ E. Breunlin,¹⁹ P. Favre and

Genuss **19**, 305; abst. Chem Zentr 1910, **81**, I, 1555

24. Sci Proc Roy. Dublin Soc 1919, **15**, 597, abst J. S. C. I 1919, **38**, 924-A.

1. J. C. S. 1919, **115**, 1194, abst J. S. C. I 1919, **38**, 924-A
2. U. S. P. 1321611, abst C. A. 1920, **14**, 223
3. J. S. C. I. 1919, **38**, 411 T.
4. J. A. C. S. 1920, **42**, 310, abst J. S. C. I. 1920, **39**, 279 A
5. Biochem. J. 1920, **14**, 73, abst J. S. C. I. 1920, **39**, 262 A.
6. Can P. 202135, 1920
7. Can Chem J. 1920, **4**, 76, abst C. A. 1920, **14**, 1405
8. J. Ind Eng Chem 1920, **12**, 481, abst C. A. 1920, **14**, 2098
9. Schw J 1811, **1**, 273, Ann Chim Phys 1812, **62**, 170
10. Museum, 1816, **7**, 106
11. Pogg Ann 1847, **72**, **1**, 223, Ann 1848, **68**, 17, 1854, **92**, 1, 1855, **94**, 257, 293; abst Chem Centr 1855, **26**, 116, 486, Jahr Chem 1847 1848, **1**, 66, 86, 1855, **8**, 33 Zts physik. Chem 1888, **2**, 185; 1891, **8**, 269, 1893, **12**, 468
12. Ann Chim Phys 1846, **16**, 129, 155, J prakt Chem 1846, **37**, 347; Ann 1846, **57**, 319, abst Berz Jahr Chem 1848, **27**, 535 See also J Ebelmen and Bouquet, Ann Chim Phys 1846, **17**, 61, J prakt Chem 1846, **38**, 214; J. Pharm 1846, **10**, 66 A Schleper, Ann 1846, **59**, 23
13. Jahr prakt Pharm **14**, 1, abst Berz Jahr Chem 1849, **28**, 461, Ann 1847, **64**, 336, Jahr Chem 1847 1848, **1**, 698, J Pharm 1846, **14**, 300
14. J Pharm 1849, **16**, 399, Chem Soc. Quart J 1849, **3**, 111, Ann 1851, **77**, 174, 1851, **77**, 114, Jahr Chem 1849, **2**, 426, 1850, **3**, 494
15. Ann 1849, **69**, 214, abst Chem Centr 1849, **20**, 225, Jahr Chem 1848-1849, **2**, 428
16. Ann Chim Phys 1845, **15**, 325, abst Jahr Chem. 1848-1849, **2**, 60, 66. Compt rend 1873, **76**, 336, abst. Jahr Chem 1873, **26**, 1080. Compt. rend 1875, **81**, 808, abst Jahr Chem 1876, **29**, 7. See also Zts. physik. Chem. 1896, **19**, 108.
17. J. prakt. Chem. 1854, **62**, 264; abst. Jahr Chem 1854, **7**, 576
18. N. Jahrb Pharm. **1**, 1, abst Ann 1854, **92**, 277, Chem Centr 1854, **25**, 274; Jahr. Chem 1854, **7**, 26.
19. Ann 1854, **91**, 314; abst. Chem Centr 1854, **25**, 835, J. prakt Chem. 1855, **44**, 44, Jahr Chem. 1854, **7**, 576

J. Silbergmann,¹ M. Berthelot,² A. Wurtz,³ J. Schlossberger,⁴ R. Railton,⁵ L. Carius,⁶ C. Gerhardt and G. Chance,⁷ H. v. Giln,⁸ H. Schwarz,⁹ Schlagdenhauffen,¹⁰ J. Schiel,¹¹ A. Perrot,¹² and L. Pasteur,¹³ in the decade following, constitute the pioneer work upon which our present-day knowledge of the subject has been perfected.

The ten-year period 1861–1870 appeared comparatively quiescent so far as radical discoveries are concerned, and is embraced in the dissertations and writings of A. Kovalevsky,¹⁴ T. Kundig,¹⁵ R. Fittig,¹⁶ H. Landolt,¹⁷ A. Wurtz,¹⁸ Brion,¹⁹ M. Berthe-

1. Ann. Chim. Phys. 1853, **37**, 461, Ann. 1853, **88**, 163, abst. Chem. Soc. Quart. J. 1853, **6**, 250. See also Zts. physik. Chem. 1890, **6**, 339, 1895, **18**, 511.

2. Compt. rend. 1853, **37**, 855, abst. Chem. Centr. 1854, **25**, 45. Compt. rend. 1863, **56**, 700, 793, 844, abst. Chem. Centr. 1863, **34**, 662, J. prakt. Chem. 1863, **90**, 244, 1864, **92**, 292.

3. Compt. rend. 1852, **35**, 300, 1862, **55**, 370, 1863, **56**, 715, 1164, 1264, **57**, 479, 1868, **66**, 1179, Ann. Chim. Phys. 1854, **42**, 129, 1857, **51**, 84, 1864, **2**, 441, Bull. Soc. Chim. 1863, **5**, 300, L'Institut 1863, 283, Ann. 1851, **79**, 280, 1853, **85**, 197, 1855, **93**, 107, 110, 1858, **104**, 232, 1863, **128**, 225, 1865, **134**, 301, 1868, **148**, 131, abst. Chem. Centr. 1863, **34**, 155, 604, 917, 1864, **35**, 232, 1868, **39**, 869, 872, Jahr. Chem. 1858, **11**, 461, 4863, **16**, 507, 1864, **17**, 502, J. prakt. Chem. 1861, **92**, 280, Zts. Chem. 1863, **6**, 417, 155, 1868, **11**, 490.

4. Ann. 1850, **73**, 212, abst. Chem. Centr. 1850, **21**, 437.

5. Chem. Soc. Quart. J. 1853, **6**, 205, abst. Jahr. Chem. 1853, **6**, 508; Chem. Centr. 1854, **25**, 256.

6. L. Carius and E. Fries, Ann. 1859, 109, 1, abst. Chem. Centr. 1859, **30**, 213, Rep. Chim. Pure, 1859, **1**, 220, Jahr. Chem. 1858, **11**, 95. L. Carius, Ann. 1859, **111**, 93, abst. J. prakt. Chem. 1859, **78**, 164, Chem. Centr. 1859, **30**, 661, Ann. Chim. Phys. 1859, **57**, 347, Rep. Chim. Pure, 1859, **1**, 579, Jahr. Chem. 1859, **12**, 87.

7. Compt. rend. 1852, **35**, 690, abst. Jahr. Chem. 1859, **12**, 88.

8. Wien Acad. Ber. **30**, 124, abst. J. prakt. Chem. 1858, **75**, 49, Chem. Centr. 1858, **29**, 595, Jahr. Chem. 1858, **11**, 402.

9. Dingl. Poly. 1858, **149**, 377, abst. Jahr. Chem. 1858, **11**, 485.

10. J. pharm. chim. 1856, **30**, 401, abst. Chem. Centr. 1857, **28**, 146, Jahr. Chem. 1856, **9**, 576.

11. Ann. 1859, **112**, 73, abst. Chem. Centr. 1860, **31**, 3, J. prakt. Chem. 1860, **79**, 252, J. pharm. chim. 1860, **37**, 144.

12. Compt. rend. 1857, **45**, 309, abst. J. prakt. Chem. 1858, **78**, 174, Ann. 1858, **105**, 64.

13. Compt. rend. 1855, **41**, 296, 1856, **42**, 1259; L'Institut 1855, 294, J. prakt. Chem. 1856, **67**, 359, 1857, **70**, 349, Ann. 1855, **96**, 255; Chem. Centr. 1855, **26**, 702, Jahr. Chem. 1855, **8**, 614, Chem. Soc. Quart. J. 1855, **8**, 277.

14. Ann. 1861, **119**, 303, abst. Bull. Soc. Chim. 1862, **4**, 174, Jahr. Chem. 1861, **14**, 586.

15. Ann. 1860, **114**, 1; abst. J. prakt. Chem. 1860, **80**, 445, Chem. Centr. 1860, **31**, 543, Zts. Chem. 1860, **3**, 9, Rep. Chim. Pure, 1860, **2**, 225; Jahr. Chem. 1860, **13**, 317.

16. Ann. 1860, **114**, 66, abst. J. prakt. Chem. 1860, **80**, 440, Zts. Chem.

- lot,¹ C. Friedel and J. Crafts,² C. Friedel,³ L. Barth,⁴ F. Gerhard,⁵ T. Graham,⁶ A. Bauer,⁷ E. Erlenmeyer,⁸ G. Wittstein,⁹ V. Regnault,¹⁰ A. Hofmann,¹¹ Lapschin and Tischenowitsch,¹² G. Krämer 1860, **3**, 519; Chem. Centr. 1860, **31**, 554; Ann. 1861, **117**, 68; abst. Chem. Centr. 1861, **32**, 143; Jahr. Chem. 1860, **13**, 319.
17. Pogg. Ann. Phys. 1864, **122**, 545; **123**, 595; abst. Jahr. Chem. 1864, **17**, 101; Chem. Centr. 1865, **36**, 112.
18. J. prakt. Chem. 1864, **92**, 284; abst. Jahr. Chem. 1864, **17**, 502, 503.
19. Compt. rend. 1863, **56**, 876; L'Institut. 1863, 158; Bull. Soc. Chim. 1863, **5**, 496; Zts. Chem. 1863, **6**, 384; J. prakt. Chem. 1863, **89**, 503; Jahr. Chem. 1863, **16**, 467.
1. L'Institut. 1862, 110; abst. Chem. Centr. 1862, **33**, 897; Jahr. Chem. 1862, **15**, 409.
2. Compt. rend. 1863, **57**, 877; abst. J. prakt. Chem. 1864, **92**, 322; Ann. 1864, **130**, 198; **131**, 55; Bull. Soc. Chim. 1864, **2**, 100; Zts. Chem. 1864, **7**, 560; abst. Jahr. Chem. 1863, **16**, 466; 1864, **17**, 460; Chem. Centr. 1864, **37**, 354; Ann. 1865, **133**, 207.
3. Ann. 1862, **124**, 326; Compt. rend. 1862, **55**, 53; Proc. Amer. Pharm. Assoc. 1863, **11**, 134; Ann. Chim. Phys. 1869, **16**, 310; abst. Zts. Chem. 1869, **12**, 486; Jahr. Chem. 1869, **22**, 512.
4. Ann. 1861, **119**, 216; Jahr. Chem. 1861, **14**, 609; Wien Acad. Ber. **43**, II, 487; Zts. Chem. 1861, **4**, 524; J. prakt. Chem. 1862, **86**, 167; abst. Chem. Centr. 1861, **32**, 705; Rep. Chim. Pure, 1861, **3**, 451. In this connection, see also A. Cahours, Ann. Chim. Phys. 1839, **70**, 81; abst. Berz. Jahr. Chem. 1841, **20**, 521.
5. Ann. 1862, **122**, 363; abst. Chem. Centr. 1862, **33**, 821; Rep. Chim. Pure, 1862, **4**, 395.
6. Phil. Trans. 1861, **151**, 373; Ann. 1862, **123**, 90; abst. Proc. Roy. Soc. Lond. 1862, **11**, 381; Compt. rend. 1861, **53**, 774; L'Institut, 1861, 384; Jahr. Chem. 1861, **14**, 35.
7. Compt. rend. 1860, **50**, 500; abst. Chem. Centr. 1860, **5**, 490; Rep. Chim. Pure, 1860, **2**, 462; Jahr. Chem. 1860, **13**, 405; Wien Acad. Ber. **44**, 87; Zts. Chem. 1861, **4**, 645; abst. J. prakt. Chem. 1860, **80**, 361; 1861, **84**, 257; Ann. Chim. Phys. 1861, **63**, 465; Rep. Chim. Pure, 1862, **4**, 110; Jahr. Chem. 1861, **14**, 659. See also A. Bauer and E. Klein, Wien Acad. Ber. **57**, II, 92; Ann. 1868, **147**, 249; Chem. Centr. 1868, **13**, 492; Jahr. Chem. 1868, **21**, 445; Bull. Soc. Chim. 1868, **10**, 412; J. prakt. Chem. 1868, **104**, 474; Zts. Chem. 1868, **11**, 379.
8. Zts. Chem. 1864, **7**, 642; abst. Jahr. Chem. 1864, **17**, 489; Ber. 1870, **3**, 809; abst. Chem. Centr. 1870, **41**, 802; Ann. 1867, Suppl. **5**, 337; Bull. Soc. Chim. 1871, **15**, 91; Jahr. Chem. 1870, **23**, 667. See also A. Friedel, Compt. rend. 1860, **50**, 53; Institut. 1863, 238; Rep. Chim. Pure, 1862, **4**, 351; N. Arch. phys. nat. **14**, 409; Ann. 1862, **124**, 324; Zts. Chem. 1862, **5**, 460; Chem. Centr. 1862, **33**, 761; Chem. News, 1862, **6**, 148; J. prakt. Chem. 1861, **84**, 437. E. Frankland and B. Duppa, J. C. S. 1867, **20**, 102; Compt. rend. 1867, **64**, 249; Ann. Chim. Phys. 1867, **11**, 487; Zts. Chem. 1867, **10**, 119; J. prakt. Chem. 1867, **101**, 50; Chem. Centr. 1867, **38**, 673; Jahr. Chem. 1865, **18**, 304. C. Stahlmann, Ann. 1868, **147**, 129; Zts. Chem. 1868, **11**, 558; Bull. Soc. Chim. 1868, **10**, 406.
9. Vierteljahrsch. prakt. Pharm. **11**, 567; abst. Jahr. Chem. 1862, **15**, 408.
10. Jahr. Chem. 1863, **16**, 77. See also Jahr. Chem. 1847-1848, **1**, 87; 1853, **6**, 79.
11. E. P. 1291, 1863.
12. N. Petersb. Acad. Bull. **4**, 81; abst. Chem. Centr. 1861, **32**, 613; Phil. Mag. 1861, **22**, 308; J. pharm. chim. 1862, **41**, 95; Jahr. Chem. 1861, **14**, 50.

and A. Pinner,¹ R. Kemper,² A. Butlerow,³ N. Bunge,⁴ J. Bogomolez,⁵ M. Chevrier,⁶ E. Chapman and W. Thorp,⁷ E. Chapman and M. Smith,⁸ A. Claus,⁹ A. Bayer,¹⁰ A. Bechamp,¹¹ B. Tollens,¹² A. Schrauff,¹³ C. Schorlemmer,¹⁴ N. Mentschutkin,¹⁵ R. Silva,¹⁶ A. Popoff,¹⁷ J. Pierre and E. Puchot,¹⁸ A. Pedler,¹⁹ and Ließ-Bodart.²⁰

From 1871-1880 augmented activity in this field appears,

1. Ber. 1869, **2**, 401; Poly. Centr. 1869, **35**, 1262; Chem. Centr. 1869, **40**, 909; Bull. Soc. Chim. 1870, **14**, 271; Jahr. Chem. 1869, **22**, 502.
2. Arch. Pharm. (2), **139**, 20; abst. Zts. Chem. 1870, **13**, 704; Jahr. Pharm. 1869, **29**, 374; Proc. Amer. Pharm. Assoc. 1870, **18**, 249.
3. Bull. Soc. Chim. 1864, **2**, 106; abst. Chem. Centr. 1865, **36**, 168. Ann. 1867, **144**, 1; abst. Chem. Centr. 1868, **39**, 361. Ber. 1877, **10**, 81; abst. Chem. Centr. 1877, **48**, 164.
4. Bull. Soc. Chim. 1866, **6**, 401; abst. Jahr. Chem. 1866, **19**, 527.
5. Ann. 1881, **209**, 70; abst. Chem. Centr. 1881, **52**, 644, 679; Jahr. Chem. 1881, **34**, 889; Bull. Soc. Chim. 1882, **35**, 503; J. C. S. 1881, **40**, 401.
6. Compt. rend. 1869, **68**, 924; abst. Zts. Chem. 1869, **22**, 413.
7. J. C. S. 1866, **19**, 477; Ann. Chim. Phys. 1867, **10**, 488; Ann. 1867, **142**, 162; abst. J. prakt. Chem. 1867, **101**, 94; Jahr. Chem. 1866, **19**, 280.
8. Proc. Roy. Soc. 1869, **17**, 308; Chem. News, 1869, **19**, 102, 198; J. C. S. 1867, **20**, 576; 1869, **22**, 193; abst. Jahr. Chem. 1869, **22**, 367; J. prakt. Chem. 1869, **107**, 259; Zts. Chem. 1869, **12**, 471.
9. Ber. Naturforsch. Ges. 1867, 497; abst. Zts. Chem. 1868, **11**, 159; J. prakt. Chem. 1867, **102**, 384; Chem. Centr. 1868, **39**, 527; Bull. Soc. Chim. 1867, **9**, 219; Jahr. Chem. 1867, **20**, 581.
10. Ber. 1869, **2**, 98; abst. Zts. Chem. 1869, **12**, 389; Jahr. Chem. 1869, **22**, 301.
11. Compt. rend. 1868, **67**, 560; abst. J. prakt. Chem. 1869, **107**, 448; Jahr. Chem. 1868, **21**, 431.
12. Zts. Chem. 1871, **14**, 249; Ann. 1871, **159**, 92; Chem. Centr. 1871, **42**, 499. Ber. 1869, **2**, 124; abst. Zts. Chem. 1869, **12**, 174.
13. Pogg. Ann. 1868, **133**, 479; abst. Jahr. Chem. 1868, **21**, 117.
14. Proc. Roy. Soc. 1867, **15**, 131. 1869, **17**, 327; Ann. 1868, **147**, 414, 217, 219; 1872, **161**, 269. Chem. Centr. 1868, **39**, 656, 660, 661; abst. Jahr. Chem. 1866, **19**, 526; J. prakt. Chem. 1866, **98**, 242; Zts. Chem. 1868, **11**, 542.
15. Petersburg Acad. Mem. **10**, 118; J. Russ. Phys. Chem. Soc. 1877, **9**, 316; 1878, **10**, 276, 316; 1879, **11**, 272; 1880, **12**, 82; 1881, **13**, 562; 1882, **14**, 62, 162; Compt. rend. 1882, **95**, 648; 1887, **105**, 1016; Bull. Soc. Chim. 1866, **6**, 481; Ber. 1878, **11**, 1507, 2117, 2148; 1909, **42**, 4020; J. C. S. 1882, **42**, 817; Zts. physik. Chem. 1887, **1**, 610; Zts. Chem. 1866, **9**, 36; J. prakt. Chem. 1866, **98**, 485; 1881, **132**, 49; 1882, **133**, 193; Ann. 1879, **195**, 334; 1866, **139**, 343; abst. Jahr. Chem. 1866, **19**, 487; 1877, **30**, 603; 1878, **31**, 513; 1881, **34**, 15; 1882, **35**, 21; Chem. Centr. 1866, **37**, 897; 1882, **53**, 154, 758, 792; 1883, **54**, 788; 1888, **59**, 4, 214; 1906, **77**, I, 1868; II, 1715; Chem. Zentr. 1909, **80**, II, 2134; 1910, **81**, I, 904.
16. Compt. rend. 1867, **64**, 1239; abst. Chem. Centr. 1868, **39**, 655.
17. Ber. 1873, **6**, 560; abst. Jahr. Chem. 1873, **26**, 303. Ann. 1868, **145**, 292; abst. Chem. Centr. 1869, **40**, 303.
18. J. pharm. chim. 1871, **13**, 369; Ann. Chim. Phys. 1868, **22**, 234; Bull. Soc. Chim. 1869, **11**, 43; 1870, **14**, 58; Compt. rend. 1868, **66**, 302; 1869, **69**, 95; 1870, **70**, 394; 1871, **73**, 599; 1873, **76**, 1532; Ann. 1872, **163**, 265; Chem. Centr. 1868, **39**, 989; 1869, **40**, 886, 969; 1870, **41**, 177; 1871, **42**, 611; 1873, **44**, 481; Jahr. rein Chem. 1873, **1**, 96; J. prakt. Chem. 1869, **108**, 191; Jahr. Chem. 1873, **26**, 174; Zts. Chem. 1877, **20**, 255. See also N.

especially upon the chemical problems connected with the isomeric amyl alcohols, and in attempts to apply them to commercial and therapeutic uses. Significant among the writings of this period may be chronicled those of J. Le Bel,¹ R. Bottger,² A. Borodin,³ A. Butlerow,⁴ P. Champion,⁵ E. Chapman,⁶ M. Croullebois,⁷ F. Flawitzky,⁸ G. Bentley,⁹ G. Bakhoven,¹⁰ F. Grimm,¹¹ E. Erlenmeyer

Levy, Ber 1873, **6**, 1362

¹⁹ Ann 1868, **147**, 213, 248, J. C. S. 1868, **21**, 74, abst Zts. Chem. 1868, **11**, 349

²⁰ J. prakt. Chem. 1866, **98**, 319, Compt. rend., 1866, **62**, 749

¹ Compt. rend. 1873, **77**, 1021; 1878, **87**, 213, 1879, **89**, 312, 1883, **96**, 1368; Bull. Soc. Chim. 1874, **21**, 542; 1876, **25**, 199, 545, 1878, **29**, 194; **30**, 148, 1879, **31**, 104, 1880, **33**, 106, Ann 1883, **220**, 149, Ber 1873, **6**, 70, 1314, 1876, **9**, 358, 732, 1879, **12**, 2163; 1880, **13**, 1029, J. C. S. 1876, **30**, 64, Jahr. rein. Chem. 1873, **1**, 97, 1874, **2**, 158, Chem. Centr. 1873, **44**, 771, 1874, **45**, 561, 1876, **47**, 548, 1878, **49**, 276, 643, 1879, **50**, 250, 450, 579, 1882, **53**, 482; Jahr. Chem. 1873, **26**, 334, 1876, **29**, 347, 346, 1878, **31**, 525; 1879, **32**, 491, 1880, **33**, 609, 1883, **36**, 1500, Chem. Ztg. 1883, **7**, 714, Zts. Spiritusind. **6**, 649, Les Mondes, 1873, **32**, 180, Chem. Tech. Rep. 1883, **22**, 11, 45, Proc. Amer. Pharm. Assoc. 1874, **22**, 236, 1879, **27**, 411

² Poly. Notizbl. 1873, **28**, 15, abst. Chem. Tech. Rep. 1873, **12**, 1, 178

³ Ber 1872, **5**, 481, abst. Chem. Centr. 1872, **43**, 451

⁴ Petersb. Acad. Bull. **16**, 290, abst. Zts. Chem. 1871, **14**, 273, Bull. Soc. Chim. 1871, **16**, 302, Chem. Centr. 1871, **42**, 450, J. C. S. 1871, **24**, 1035; Jahr. Chem. 1871, **24**, 115

⁵ Compt. rend. 1871, **73**, 573; Bull. Soc. Chim. 1874, **22**, 612, abst. Jahr. Chem. 1871, **24**, 375

⁶ J. C. S. 1866, **19**, 333, abst. Chem. Centr. 1867, **38**, 269, J. C. S. 1870, **23**, 96, abst. Zts. Chem. 1870, **13**, 406, Bull. Soc. Chim. 1870, **14**, 55, Jahr. Chem. 1870, **23**, 121, Chem. Centr. 1870, **41**, 307, J. Feder. Inst. Brewing, **3**, 240, abst. Mon. Sci. 1897, **50**, 910, Jahr. Chem. 1897, **50**, 2799.

⁷ Ann. Chim. Phys. 1871, **22**, 139, abst. Jahr. Chem. 1871, **24**, 153.

⁸ N. Petersb. Acad. Bull. **18**, 78, abst. Ber 1872, **5**, 479, Bull. Soc. Chim. 1873, **19**, 309; Ann. 1873, **165**, 157, **169**, 205, Chem. Centr. 1872, **43**, 449, 1873, **44**, 2, J. C. S. 1873, **26**, 15, 369, Jahr. Chem. 1872, **25**, 347, Ber 1873, **6**, 195, Ann. 1875, **175**, 380, Chem. Centr. 1874, **45**, 419, Jahr. Chem. 1873, **26**, 259, N. Petersb. Acad. Bull., **18**, 516, Ber 1873, **6**, 502, Bull. Soc. Chim. 1873, **20**, 372, Chem. Centr. 1873, **46**, 709, Jahr. Chem. 1873, **26**, 336, Ber 1874, **7**, 1650; abst. Chem. Centr. 1875, **46**, 50, Jahr. Chem. 1874, **27**, 332, Ann. 1875, **175**, 380, abst. Chem. Centr. 1875, **46**, 178, Jahr. Chem. 1875, **28**, 268, Ber 1875, **8**, 263, Ann. 1875, **179**, 340, abst. Chem. Centr. 1876, **47**, 309, 819, Jahr. Chem. 1875, **48**, 280, Ber 1876, **9**, 267, 819, abst. Chem. Centr. 1876, **47**, 226, Jahr. Chem. 1876, **29**, 7, Ber. 1876, **9**, 1600, Gaz. chim. ital. 1876, **6**, 524, abst. Jahr. Chem. 1875, **28**, 280, 1876, **29**, 349, Ber. 1877, **10**, 230; abst. Bull. Soc. Chim. 1877, **27**, 501; Chem. Centr. 1878, **49**, 243, Jahr. Chem. 1877, **30**, 533, Ber 1877, **10**, 2240; abst. Chem. Centr. 1878, **49**, 262, Jahr. Chem. 1877, **30**, 534, 626, Ber. 1887, **20**, 1948, abst. Chem. Centr. 1887, **58**, 1071.

⁹ E. P. 2262, 1874

¹⁰ Pogg. Ann. 1873, Suppl. **6**, 325; abst. Jahr. rein. Chem. 1873, **1**, 96; J. prakt. Chem. 1873, **116**, 272, Chem. Centr. 1873, **44**, 643; Jahr. Chem. 1873, **26**, 335

¹¹ Ann. 1871, **157**, 249, abst. Zts. Chem. 1871, **14**, 173; Chem. Centr. 1871, **42**, 471; J. C. S. 1871, **24**, 385, Bull. Soc. 1871, **15**, 233; Jahr. Chem. 1871, **24**, 419, 532.

and C. Hell,¹ E. Wagner and A. Saytzeff,² A. Naumann,³ P. Toepler,⁴ N. Ley,⁵ A. Lieben and A. Rossi,⁶ J. Kobig,⁷ Dujardin-Beaumetz and Audige,⁸ A. Cahours and E. Demareay,⁹ G. Fleury,¹⁰ L. Balbiano,¹¹ J. Gladstone and A. Tribe,¹² W. Alexejeff,¹³ E. Amagat,¹⁴ A. Wischnegradski,¹⁵ Aymonnet,¹⁶ H. Werner,¹⁷ H. Vogel,¹⁸ A. Eltekoff,¹⁹ J. Schoenn,²⁰ O. Schmiedeberg and E. Hanak,²¹ A. Richardson,²² J. Regnault and E. Hardy,²³ A. Rabuteau,²⁴ W.

1 Ber. 1870, **3**, 809, Ann 1871, **160**, 257, abst Chem Centr 1872, **43**, 589, Zts. Chem 1871, **14**, 577, Jahr Chem 1871, **24**, 580, 587, Bull Soc Chim 1871, **15**, 90, 1872, **17**, 169

2 Ber 1873, **6**, 1512, abst Jahr Chem 1873, **26**, 336, Arch Pharm 1874, (3), **4**, 485, N. Rep Pharm **23**, 596, Jahr rem Chem 1874, **2**, 158, Chem Centr 1874, **45**, 213, Ann 1875, **175**, 351, abst Jahr Chem 1875, **28**, 277, Ber 1874, **7**, 1650, Chem Centr 1875, **46**, 50, Ber 1875, **8**, 1682, abst Chem Centr 1876, **47**, 115, Jahr Chem 1876, **29**, 312

3 Ber 1874, **7**, 207, 2081, abst Jahr Chem 1874, **27**, 17

4 E. P. 2715, 1870, abst Ber 1870, **3**, 531, Dent. Musterztg 1871, 253, Chem Tech Rep 1871, **10**, II, 3. See also E. Richter, Chem Tech Rep 1869, **8**, II, 2

5 Ber 1873, **6**, 1254, 1367, abst J. C. S 1874, **27**, 350, Chem Centr 1873, **44**, 802, Jahr Chem 1873, **26**, 336

6 J. prakt. Chem 1871, **111**, 459, Gaz. chim. ital 1871, **1**, 311

7 Ann 1879, **195**, 99, abst Chem Centr 1879, **50**, 196

8 Compt rend 1875, **81**, 192, abst Chem Centr 1875, **46**, 807

9 Compt rend 1876, **83**, 688, abst Chem Centr 1876, **47**, 714, Compt rend 1878, **86**, 991, abst Chem Centr 1878, **49**, 101, Bull Soc Chim 1878, **29**, 486

10 Compt rend 1877, **84**, 1169, abst Jahr Chem 1877, **30**, 1079

11 Gaz. chim. ital 1876, **6**, 229, 102, Ber 1876, **9**, 1337, 1692, abst Bull Soc Chim 1877, **27**, 27, Chem Centr 1876, **47**, 786, 1877, **48**, 52, Jahr Chem 1876, **29**, 318

12 Chem News, 1875, **32**, 277, J. C. S 1876, **29**, 158, abst Chem Centr 1876, **47**, 68, Jahr Chem 1876, **29**, 329, Chem News, 1880, **42**, 2, abst Jahr Chem 1880, **33**, 1178

13 Ber 1875, **8**, 265, 1876, **9**, 1142, 1877, **10**, 110, 112, 1879, **12**, 2172, abst Chem Tech Rep 1875, **14**, II, 291, Chem Centr 1875, **46**, 240, 1876, **47**, 786, 1877, **48**, 310, 1880, **49**, 20, Bull Soc Chim 1877, **27**, 370, 445, Jahr Chem 1876, **29**, 17, 1877, **30**, 75, 1879, **32**, 105, Wied Ann Phys 1886, **28**, 315

14 Ann Chim Phys 1877, **11**, 520, Compt rend 1877, **85**, 27, 139, abst Jahr. Chem 1877, **30**, 70. See also Zts. physik. Chem 1896, **19**, 111

15 Ber 1876, **9**, 1028, 1599, Gaz. chim. ital 1875, **5**, 521, abst Jahr Chem 1876, **29**, 319, Chem Centr 1876, **47**, 595, Ann 1878, **190**, 328, 353, 365, Ber 1877, **10**, 81, 1878, **11**, 253, abst Bull Soc Chim 1877, **27**, 452, J. C. S 1878, **34**, 393, Pogg. Ann Phys Beibl 1879, **3**, 206

16 Compt rend 1876, **83**, 971, abst Chem Centr 1877, **48**, 19

17 Ber 1878, **11**, 1382, abst Chem Tech Rep 1878, **17**, I, 457, Arch Pharm. (3), **12**, 481

18 Ber. 1878, **11**, 622, 913, 1362, Berl Acad Ber 1878, 109, abst Jahr Chem. 1878, **31**, 177

19 Ber. 1877, **10**, 704, 1904, abst Chem Centr 1878, **49**, 18

20 Wied Ann. Phys 1879, **6**, 267, abst Jahr Chem 1879, **32**, 149.

21 Arch exp Path **5**, 101, abst Chem Centr 1876, **47**, 554.

22 J. C. S. 1886, **49**, 761, abst Jahr Chem 1886, **39**, 102. See also

Pitchford,¹ J. Osipoff,² R. Herrmann,³ L. Haitinger,⁴ and A. Lieben, and F. Loidl.⁵

It was within the period 1881-1890 that the first discoveries of the value of amyl acetate as a pyroxylin solvent were made, and also the period in which was laid the foundation of our modern pyroxylin lacquer and bronzing liquid industries. It is not surprising, therefore, that a recrudescence in investigative activity in this field should appear, and this is reflected in the contributions of D. Konowaloff,⁶ F. Just,⁷ J. Kononnikoff,⁸ G. Kahlbaum,⁹ A. Destrem,¹⁰ Dujardin,¹¹ D. Djakonoff,¹² J. Bogomolez,¹³ J. Brühl,¹⁴ A. Calm,¹⁵ A. Clermont,¹⁶ J. Frentzel,¹⁷ K. Bauer,¹⁸ G.

Zts. physik. Chem. 1891, **8**, 644.

23. J. pharm. chim. 1879, **30**, 405; abst. Chem. Centr. 1879, **50**, 787.

24. Compt. rend. 1875, **81**, 631; abst. Jahr. Chem. 1875, **28**, 887.

1. E. P. 726, 1875.

2. Ber. 1875, **8**, 542, 1240; abst. Chem. Centr. 1875, **46**, 388, 722;

J. C. S. 1876, **29**, 544.

3. J. prakt. Chem. 1876, **121**, 28, 395; 1878, **125**, 49, 289; abst. Jahr. Chem. 1876, **29**, 17; 1878, **31**, 26; Chem. Centr. 1879, **50**, 579.

4. Ann. 1878, **193**, 366; Wien. Acad. Ber. **77**, II, 428; **86**, II, 608, Monatsh. 1882, **3**, 688; abst. Jahr. Chem. 1878, **31**, 705; 1882, **35**, 481; Bull. Soc. Chim. 1879, **32**, 250; 1883, **39**, 142; Chem. Centr. 1878, **49**, 705; 1882, **53**, 625; J. C. S. 1881, **40**, 1116; 1883, **44**, 127; Zts. Spiritusind. **6**, 589; Proc. Amer. Pharm. Assoc. 1884, **32**, 266; Chem. Ztg. 1882, **6**, 961; Chem. Tech. Rep. 1882, **21**, II, 58.

5. Ber. 1875, **8**, 1017; abst. Chem. Centr. 1875, **46**, 659.

6. Ber. 1884, **17**, 1531; abst. Bull. Soc. Chim. 1884, **41**, 551; Jahr. Chem. 1884, **37**, 96. Zts. physik. Chem. 1888, **2**, 380; abst. Chem. Centr. 1888, **59**, 913; Jahr. Chem. 1888, **41**, 337.

7. Ann. 1883, **220**, 146; abst. Chem. Centr. 1883, **54**, 741; Bull. Soc. Chim. 1884, **42**, 83; Jahr. Chem. 1883, **36**, 501.

8. Bull. Soc. Chim. 1881, **36**, 557; Ber. 1881, **14**, 1697; abst. Jahr. Chem. 1881, **34**, 313.

9. Ber. 1883, **16**, 2476; 1884, **17**, 1245; abst. Bull. Soc. Chim. 1884, **41**, 610; Jahr. Chem. 1884, **37**, 186. Zts. physik. Chem. 1891, **8**, 644; 1898, **26**, 650. See also C. Kahlbaum, D. R. P. 66866, 1891; abst. Wag. Jahr. 1893, **39**, 514. H. Kaufmann, Zts. physik. Chem. 1899, **28**, 694.

10. Compt. rend. 1880, **90**, 1213; abst. Chem. Centr. 1880, **51**, 392; Jahr. Chem. 1880, **33**, 591.

11. Dingl. Poly. 1879, **234**, 406; Chem. Centr. 1880, **51**, 172.

12. J. Russ. Phys. Chem. Soc. 1882, **14**, 2; abst. Bull. Soc. Chim. 1882, **38**, 172; Jahr. Chem. 1882, **35**, 106; Chem. Centr. 1882, **54**, 743.

13. Ann. 1881, **209**, 70; abst. Chem. Centr. 1881, **52**, 614; J. Russ. Phys. Chem. Soc. 1881, **13**, 395.

14. Ann. 1880, **203**, 12, 268; abst. Ber. 1880, **13**, 1119; Jahr. Chem. 1880, **33**, 5; Chem. Centr. 1880, **51**, 481. See also Ann. 1880, **203**, 255; Ber. 1880, **13**, 1520. Zts. physik. Chem. 1891, **7**, 150, 159.

15. Ber. 1882, **15**, 1642; abst. Chem. Centr. 1882, **53**, 662; J. C. S. 1882, **42**, 1284; Bull. Soc. Chim. 1882, **38**, 633; Jahr. Chem. 1882, **35**, 544.

16. Compt. rend. 1883, **96**, 437; abst. Chem. Centr. 1883, **54**, 214.

17. Ber. 1883, **16**, 743; abst. Jahr. Chem. 1883, **36**, 862; Chem. Centr. 1884, **55**, 9; Bull. Soc. Chim. 1883, **40**, 205; J. C. S. 1883, **44**, 1075. See

- Bergeron and I. L'Hôte,¹ G. Bertoni and F. Truffi,² A. Goldberg,³ F. Wibel,⁴ J. Field and H. Ujhely,⁵ A. Vogel,⁶ S. Schubert,⁷ R. Schiff,⁸ M. Reis,⁹ N. Menschutkin and D. Konowalow,¹⁰ V. Merz and W. Weith,¹¹ D. Vitali,¹² V. Studel,¹³ R. Plimpton,¹⁴ W. Perkin,¹⁵ K. Olszewski,¹⁶ M. Nenki and N. Sieber,¹⁷ L. Norton and C. Prescott,¹⁸ C. Hell and F. Urech,¹⁹ N. Habersack,²⁰ H. Hager,²¹ B. Lachowicz,²² E. Lecher and J. Perntner,²³ W. Louguinine,²⁴ G. also A. Franchimont and T. Zincke, Ber. 1871, **4**, 822; Ann. 1872, **163**, 193; abst. Jahr. Chem. 1871, **24**, 420. A. Lieben and G. Janacek, Wien. Acad. Ber. **75**, I, 345; Ann. 1877, **187**, 126; abst. Jahr. Chem. 1877, **30**, 534.
18. Ann. 1883, **220**, 158; abst. Jahr. Chem. 1883, **36**, 592; Chem. Centr. 1883, **54**, 744; J. C. S. 1884, **46**, 167; Bull. Soc. Chim. 1884, **42**, 30.
1. Compt. rend. 1880, **91**, 390; abst. Chem. Centr. 1880, **51**, 713; Jahr. Chem. 1880, **33**, 1210.
2. Rev. chim. med. farm. **1**, 473; Ann. chim. farm. (4), **1**, 273; **4**, 273; Gaz. chim. ital. 1884, **14**, 23; Suppl. **6**, 427; 1886, **16**, 512; abst. Chem. Centr. 1884, **55**, 667; 1887, **58**, 35; J. C. S. 1884, **46**, 1110; 1888, **52**, 458; Jahr. Chem. 1883, **36**, 853; 1886, **39**, 1208.
3. J. prakt. Chem. 1881, **132**, 97; abst. Jahr. Chem. 1881, **34**, 562; Chem. Centr. 1881, **52**, 611; Bull. Soc. Chim. 1881, **35**, 210.
4. D. R. P. 18226, 1881; abst. Ber. 1882, **15**, 1467; Jahr. Chem. 1882, **35**, 1401.
5. E. P. 2517, 1882. D. R. P. 23153, 1882; abst. Wag. Jahr. 1883, **29**, 950; Mon. Sci. 1885, **27**, 489; Jahr. Chem. 1885, **38**, 2154.
6. Bayer. Ind. y. Gewerbebl. 1881, 102; abst. Poly. Notizbl. 1881, **36**, 92; Chem. Centr. 1881, **52**, 381.
7. Wien. Acad. Ber. 1883, **86**, 608; abst. J. C. S. 1883, **44**, 60.
8. Gaz. chim. ital. 1881, **11**, 517; abst. Ber. 1882, **15**, 2761; Ann. 1883, **220**, 101. See also Zts. physik. Chem. 1887, **1**, 389.
9. Wied. Ann. Phys. 1881, **13**, 447; abst. Jahr. Chem. 1881, **34**, 1093.
10. Ber. 1884, **17**, 1361; abst. J. C. S. 1884, **46**, 1119.
11. Ber. 1881, **14**, 2343; abst. Jahr. Chem. 1881, **34**, 455.
12. L'Orosi, **6**, 327; Arch. Pharm. **221**, 964; abst. Wag. Jahr. 1884, **30**, 451.
13. Wied. Ann. phys. 1882, **16**, 369; abst. Jahr. Chem. 1882, **35**, 62.
14. Compt. rend. 1880, **91**, 433; 1881, **92**, 531, 882; J. C. S. 1881, **39**, 331; abst. Chem. Centr. 1880, **51**, 650; Jahr. Chem. 1880, **33**, 517; 1881, **34**, 411.
15. J. C. S. 1884, **45**, 470; abst. Jahr. Chem. 1884, **37**, 305.
16. Monatsh. 1884, **5**, 127; abst. Chem. Centr. 1884, **55**, 148; Jahr. Chem. 1884, **37**, 180. See also Zts. physik. Chem. 1903, **44**, 380. Mem. R. accad. Lincei, 1901, 317.
17. Ber. 1884, **17**, 2267; Arch. exper. Path. u. Pharm. **18**, 401; abst. Jahr. Chem. 1884, **37**, 1485.
18. Amer. Chem. J. 1884, **6**, 241; abst. Chem. Centr. 1885, **56**, 221; Jahr. Chem. 1884, **37**, 904. See also G. Lunge, V. Meyer and E. Schulze, Chem. Centr. 1884, **55**, 854.
19. Ber. 1882, **15**, 1107, 1249; abst. Chem. Centr. 1882, **53**, 470; Jahr. Chem. 1882, **35**, 639; Bull. Soc. Chim. 1882, **38**, 409.
20. Industriebl. 1883, 278; abst. Chem. Tech. Rep. 1883, **22**, II, 49.
21. Chem. Centr. 1886, **57**, 319, 332; abst. Jahr. Chem. 1886, **39**, 2115.
22. Ann. 1883, **220**, 168, 179, 185; abst. Jahr. Chem. 1883, **36**, 521; Chem. Centr. 1883, **54**, 740; Bull. Soc. Chim. 1884, **42**, 32.
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- Kassner,¹ J. Kalbukoff,² Dreyfus,³ J. Dewar and J. Fleming,⁴ W. Dunstan,⁵ L. Boruki,⁶ J. Boguski,⁷ G. Buschan,⁸ A. Brjuchon-
nenko,⁹ A. Brown,¹⁰ E. Claudon and C. Morin,¹¹ T. Carnelley and
A. Thomson,¹² A. Claus and E. Trainer,¹³ G. Costa,¹⁴ E. Conrady,¹⁵
J. Crafts,¹⁶ E. Colm and L. Arons,¹⁷ B. Fischer,¹⁸ Bals and Broglio,¹⁹
R. De Forcand,²⁰ L. Gratz,²¹ G. Grassi,²² F. Gurtler,²³ S. Arrhenius,²⁴
A. v. Asboth,²⁵ A. Winkelmann,²⁶ P. Wulf,²⁷ H. Weber,²⁸ J. Thomp-
Chem. 1880, **33**, 102
24. Compt rend 1880, **90**, 367, 1270, **91**, 297, 329, abst J. C. S. 1880,
38, 787, Ann Chim Phys 1880, **19**, 558, **20**, 139, 1882, **25**, 140; Jahr Chem
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Chem. Centr. 1880, **51**, 197, 675. See also Zts. physik. Chem. 1904, **49**, 37.
1. Arch. Pharm. (3), **23**, 211, abst. Chem. Centr. 1885, **56**, 462; Jahr
Chem. 1885, **38**, 1906, Pied. Centr. 1885, **14**, 499.
2. Zts. physik. Chem. 1888, **2**, 561, 1889, **4**, 432.
3. Compt. rend. 1887, **105**, 523, abst. Zts. physik. Chem. 1888, **2**, 246.
4. Proc. Roy. Soc. 1898, **62**, 250, abst. J. C. S. 1898, **74**, II, 281, Chem.
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5. Pharm. J. Trans. 1889, 185, 187, abst. Chem. Centr. 1889, **70**, I,
187.
6. Inaugural Dissertation, abst. Chem. Centr. 1887, **68**, 508, Jahr.
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7. Zts. physik. Chem. 1888, **2**, 122, 185, abst. J. C. S. 1888, **54**, 1019,
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8. Ber. Klm. Wochenschr. **25**, 228, abst. Chem. Centr. 1888, **69**, 608.
9. J. prakt. Chem. 1899, **167**, 45, abst. J. C. S. 1899, **76**, II, 265.
10. J. C. S. 1886, **49**, 172, Chem. News, 1886, **53**, 55, abst. Chem. Centr.
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11. Compt. rend. 1887, **104**, 1109, 1187, Bull. Soc. Chim. 1888, **49**, 55,
abst. Jahr. Chem. 1887, **40**, 2652, Chem. Centr. 1887, **68**, 639, 640, Chem.
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12. J. C. S. 1888, **53**, 782, Zts. physik. Chem. 1889, **3**, 48.
13. Ber. 1886, **19**, 3004, abst. Jahr. Chem. 1886, **39**, 1625.
14. Wied. Ann. Phys. Beibl. 1888, **12**, 239, abst. Jahr. Chem. 1888,
41, 1417.
15. Zts. physik. Chem. 1889, **3**, 216. See also Ann. 1888, **246**, 223.
16. Ber. 1887, **20**, 709, abst. Zts. physik. Chem. 1887, **1**, 420.
17. Wied. Ann. Phys. 1888, **33**, 13, abst. Zts. physik. Chem. 1888, **2**,
348, 1894, **14**, 298.
18. Zts. allg. Oesterr. Apoth. Ver. **41**, 389, abst. Chem. Centr.
1887, **58**, 1152.
19. Nouv. remedies 1888, 218, Pharm. Ztg. Berlin, **33**, 158, abst. Chem.
Centr. 1888, **59**, 1170.
20. Compt. rend. 1887, **104**, 169, abst. Chem. Centr. 1887, **58**, 266,
267, 268; Jahr. Chem. 1887, **40**, 212. For butyl sebacate, see G. Gehring,
Compt. rend. 1887, **104**, 1289, abst. Chem. Centr. 1887, **58**, 651, Jahr. Chem.
1887, **40**, 1840.
21. Wied. Ann. Phys. 1888, **34**, 25, abst. Zts. physik. Chem. 1888, **2**, 510.
22. Wied. Ann. Phys. Beibl. 1888, **12**, 242, abst. Jahr. Chem. 1888, **41**,
1417.
23. Ber. Klm. Wochenschr. **25**, 99, abst. Chem. Centr. 1888, **59**, 474.
24. Zts. physik. Chem. 1887, **1**, 289, 290, 1892, **9**, 505.
25. Chem. Ztg. 1889, **13**, 871, abst. Chem. Centr. 1889, **60**, II, 423;
J. S. C. I. 1889, **8**, 734; Jahr. Chem. 1889, **42**, 2780.
26. Wied. Ann. Phys. 1885, **26**, 105, 134; abst. Zts. physik. Chem. 1891,

son,¹ L. v. Udranzky,² J. Uffelman, ³ C. Schone, ⁴ J. Schönn, ⁵ A. Romegialli, ⁶ J. v. Mering, ⁷ F. Stohmann, ⁸ L. Naudin, ⁹ S. Henriksen, ¹⁰ K. Hartwig, ¹¹ M. Hamberg, ¹² L. Lindet, ¹³ A. Lieben and S. Zeisel¹⁴ and L. Liebermann.¹⁵

Advancements in the art of fluid pyroxylin combinations, stimulated by the applications of amyl acetate and to a lesser extent other amyl derivatives, gave increased impetus to researches among the amyl alcohols. Among the data accumulated during this ten-year period may be recorded that contributed by J. Kondakoff,¹⁶ H. Jahn and G. Moller,¹⁷ G. Schmidt,¹⁸ C. Schall

8, 171

27. Dissertation, Berlin, 1885, abst. Chem. Centr. 1885, **56**, 847, Jahr Chem. 1885, **38**, 159

28. Berl. Acad. Ber. 1885, 809, abst. Jahr Chem. 1885, **38**, 122

1. "Thermochemical Investigation," **4**, 1882-1886, abst. Jahr Chem. 1885, **38**, 181

2. Zts. physiol. Chem. 1888, **13**, 148, abst. Amer. J. Pharm. 1889, **61**, 133, N. Erf. u. Erfahr. 1889, **16**, 370, Bayer. Ind. u. Gewerbebl. 1889, **21**, 699, Chem. Ind. 1889, **12**, 85, Chem. Tech. Rep. 1888, **27**, II, 244, 1889, **28**, 1, 244

3. Archiv. Hygiene, abst. Wag. Jahr. 1886, **32**, 838, Dmgd. Poly. 1886, **261**, 439, Chem. Centr. 1886, **57**, 831, Jahr Chem. 1886, **39**, 1958

4. J. prakt. Chem. 1885, **140**, 241, abst. Jahr Chem. 1885, **38**, 1203

5. Zts. physik. Chem. 1888, **2**, 329, cf. Wied. Ann. Phys. 1879, **6**, 267, Rec. trav. Chim. Pays Bas, 1897, **16**, 1, abst. Zts. physik. Chem. 1898, **27**, 175

6. Gaz. chim. ital. 1886, **16**, 73, abst. Jahr Chem. 1886, **39**, 1871

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See also Chem. Centr. 1887, **58**, 1136, Therap. Monatsh. 1887, No. 7, Fortschr. Med. **5**, 631, Zts. allg. oester. Apoth. Ver. **41**, 321, abst. Chem. Centr. 1887, **58**, 1092

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9. Mon. Sci. 1889, **33**, 40, Bull. Soc. Chim. 1889, **51**, 16. See also Mon. Sci. 1882, **24**, 238. In this connection compare L. Gouffroy, Compt. rend. 1887, **105**, 122, abst. Chem. Centr. 1887, **58**, 1064, 1889, **60**, 1, 331

10. Wied. Ann. Phys. 1888, **34**, 180, abst. Zts. physik. Chem. 1888, **2**, 548, 549

11. Wied. Ann. 1888, **33**, 58, abst. Zts. physik. Chem. 1888, **2**, 346

12. Allgem. Brauer v. Hopfenz. 1886, No. 29, abst. Wag. Jahr. 1886, **32**, 814

13. Compt. rend. 1886, **103**, 1014, abst. Chem. Centr. 1886, **57**, 193, Bull. Soc. Chim. 1886, **45**, 149, Jahr Chem. 1886, **50**, 430

14. Monatsh. 1886, **7**, 53, abst. Chem. Centr. 1886, **57**, 468, Jahr Chem. 1886, **39**, 1630

15. Chem. Ztg. 1889, **13**, 829, 870, abst. Chem. Centr. 1889, **60**, II, 271, 424

16. J. prakt. Chem. 1893, **156**, 479, 1896, **162**, 442, 194, abst. J. C. S. 1897, i, 210; Jahr Chem. 1896, **49**, 624, Bull. Soc. Chim. 1897, **18**, 626

17. Zts. physik. Chem. 1894, **13**, 395, abst. J. C. S. 1894, **66**, ii, 265

18. Zts. physik. Chem. 1891, **8**, 646; abst. J. C. S. 1891, **60**, 969, 1892, **62**, 396

and L.¹ Kossakowsky,¹ H. Landolt and H. Jahn,² A. Brochet,³ Fabriques de Produits Chimiques de Thann et Mulhouse,⁴ M. Freund and F. Lenze,⁵ Bardy and Bequard,⁶ H. Goldschmidt and S. Freund,⁷ C. Guldberg,^{8,9} A. Wohl,¹⁰ A. Wolkow,¹¹ L. Tissier,¹² G. Wagner,¹³ W. Röntgen and L. Zehnder,¹⁴ W. Tschegljaew,¹⁵ J. Traube and O. Neuberg,¹⁶ T. Thorpe and L. Jones,¹⁷ J. Thomsen,¹⁸ C. Thwing,¹⁹ J. Verschaefelt,²⁰ O. Schonrock,²¹ G. Schmidt,²² W. Rogers,²³ B. Rayman and K. Kruis,²⁴ L. Simon,²⁵ S. Pickering,²⁶ H.

1. Zts. physik. Chem. 1891, **8**, 269; abst. J. C. S. 1891, **60**, 1316.
2. Zts. physik. Chem. 1892, **10**, 302, 317, 318; abst. Jahr. Chem. 1892, **45**, 473; Chem. Centr. 1892, **63**, I, 817.
3. Compt. rend. 1892, **114**, 1538; 1894, **118**, 1280; 1895, **121**, 648; Ann. Chim. Phys. 1897, **10**, 381; abst. J. C. S. 1899, **76**, i, 100; Bull. Soc. Chim. 1899, **15**, 20; Chem. Centr. 1892, **63**, II, 287; 1894, **65**, II, 143; 1895, **66**, I, 419; II, 1113; 1897, **68**, I, 801.
4. E. P. 12980, 20521, 1894; 10946, 15762, 1895; abst. J. S. C. I. 1894, **13**, 781, 1129; 1895, **14**, 595, 626, 846, 885; 1896, **15**, 314, 375, 671.
5. Ber. 1890, **23**, 1865; 1891, **24**, 2150; abst. Chem. Centr. 1890, **61**, II, 646; 1891, **62**, II, 526; Jahr. Chem. 1890, **43**, 1137; Bull. Soc. Chim. 1891, **6**, 310.
6. Rev. intern. des Fals. 1894, **7**, 63; abst. Chem. Centr. 1894, **65**, I, 305.
7. Zts. physik. Chem. 1894, **14**, 395; abst. J. C. S. 1894, **66**, ii, 405.
8. Zts. physik. Chem. 1890, **5**, 374; 1891, **7**, 612; 1900, **32**, 124.
9. Zts. physik. Chem. 1894, **15**, 638, 642; 1895, **17**, 711; 1908, **61**, 633; Ber. 1905, **38**, 345; abst. Chem. Centr. 1895, **66**, I, 315; 1899, **70**, II, 3; 1905, **66**, I, 793; 1907, **78**, I, 582; Jahr. Chem. 1899, **52**, 142; 1905-1908, I, 159; J. prakt. Chem. 1899, **167**, 470, 596; Chem. Ztg. 1906, **30**, 1155.
10. E. P. 11216, 1894; abst. J. Soc. Dyers Col. 1894, **10**, 143; J. S. C. I. 1894, **13**, 682; 1895, **14**, 534, 595.
11. Zts. physiol. Chem. 1889, **21**, I, 327; abst. Chem. Centr. 1890, **61**, II, 42.
12. Bull. Soc. Chim. 1891, **5**, 49; 1893, **9**, 100; Ann. Chim. Phys. 1893, **29**, 321; abst. J. C. S. 1893, **64**, i, 542; Chem. Centr. 1891, **62**, I, 399; 1893, **64**, I, 599; II, 358; Chem. Ztg. Rep. 1893, **17**, 63; Proc. Amer. Pharm. Assoc. 1894, **42**, 1190.
13. J. prakt. Chem. 1891, **152**, 308; abst. Chem. Centr. 1891, **62**, II, 843.
14. Zts. physik. Chem. 1892, **9**, 226. Wied. Ann. Phys. 1891, **44**, I, 23, 24.
15. Zts. physik. Chem. 1892, **9**, 92. J. Russ. Phys. Chem. Soc. 1891, **23**, I, 170.
16. Ber. 1891, **24**, 520; abst. Chem. Centr. 1891, **62**, I, 611.
17. J. C. S. 1893, **63**, 281; abst. Zts. physik. Chem. 1893, **11**, 840.
18. See F. Stohmann, Zts. physik. Chem. 1890, **6**, 340.
19. Zts. physik. Chem. 1894, **14**, 293; abst. J. C. S. 1894, **66**, ii, 374.
20. Zts. physik. Chem. 1894, **15**, 439. See also Proc. Amer. Pharm. Assoc. 1893, **41**, 87, 88.
21. Zts. physik. Chem. 1893, **11**, 760, 766, 767; **16**, 38, 39.
22. Zts. physik. Chem. 1891, **8**, 641; abst. J. C. S. 1891, **60**, 969.
23. J. C. S. 1893; **63**, 1130; abst. Chem. Centr. 1893, **64**, II, 713; Jahr. Chem. 1893, **46**, 652; Proc. Amer. Pharm. Assoc. 1894, **42**, 1189.
24. Mitth. Versuchstation für Spiritusind. in Prag, 1891, 1; abst. Jahr. Chem. 1891, **44**, 2767. Mon. Sci. 1896, **48**, 713; abst. Jahr. Chem. 1896, **49**, 2005. Zts. Brauwesen, 1895, 190; abst. Wag. Jahr. 1895, **41**, 864. Akad.

- Pfeiffer,¹ E. Pfitzer,² L. Pedrix,³ L. Paget,⁴ T. Krit,⁵ W. Nernst,⁶ Farbw. vorm. Meister, Lucius & Brünig,⁷ W. Luginin,⁸ W. Kerp,⁹ P. Drude,¹⁰ H. Borntrager,¹¹ C. Boehringer & Soehne,¹² G. Carrara and G. Gennari,¹³ M. Centnerzwer,¹⁴ F. Bayer & Co.,¹⁵ H. Fenton and H. Jackson,¹⁶ J. Fleming and J. Dewar,¹⁷ P. Frankland and T. Price,¹⁸ E. Beckmann and G. Fuchs,¹⁹ E. Beckmann, G. Fuchs and V. Gernhardt,²⁰ W. Biltz,²¹ C. Gassmann and Soc. Chim. des usines du Rhone,²² L. Gentil,²³ F. Gooch,²⁴ Gretsch & Mayer,²⁵ P. Guye and A. de Armal,²⁶ P. Guye and L. Chavanne,²⁷ Wiss. Bochmen, 1903; abst. Chem. Centr. 1904, **75**, I, 736; Jahr. Chem. 1904, **57**, 2121. Wochenschr. f. Brauerei, 1904, **21**, 25.
25. Bull. Soc. Chim. 1894, **11**, 674; Chem. Centr. 1894, **65**, II, 404.
 26. Zts. physik. Chem. 1890, **6**, 10; abst. Chem. Centr. 1890, **61**, II, 574.
 1. Zts. physik. Chem. 1892, **9**, 444, 469; abst. Chem. Centr. 1892, **45**, 201.
 2. D. R. P. 48755, 1888; abst. Ber. 1889, **22**, 718. D. R. P. 57630, 1890; abst. Wag. Jahr. 1891, **37**, 550.
 3. Zts. Spiritusind. 1891, **14**, 177; abst. Wag. Jahr. 1891, **37**, 1004; Ann. Inst. Pasteur, 1891, No. 5; J. S. C. I. 1892, **11**, 690.
 4. E. P. 7784, 1893; abst. J. S. C. I. 1893, **12**, 483, 646, 701.
 5. Zts. physik. Chem. 1891, **7**, 605. Ber. 1882, **15**, 2463.
 6. Zts. physik. Chem. 1894, **14**, 659; abst. J. C. S. 1894, **66**, ii, 437.
 7. E. P. 24901, 1894; abst. J. S. C. I. 1895, **14**, 94, 100, 1008, 1061.
 8. Zts. physik. Chem. 1890, **6**, 339; Ann. Chim. Phys. 1880, (5), **21**, 142. Zts. physik. Chem. 1895, **17**, 176; Compt. rend. 1894, **119**, 601, 645.
 9. Zts. physik. Chem. 1895, **18**, 511. J. C. S. 1899, **76**, ii, 269.
 10. Ber. 1895, **28**, 1476; abst. J. C. S. 1895, **68**, i, 538; Jahr. Chem. 1895, **48**, 986; Bull. Soc. Chim. 1895, **14**, 1207; Chem. Centr. 1895, **66**, II, 437. See also J. Kuenen and W. Robson, Zts. physik. Chem. 1890, **28**, 342; abst. J. C. S. 1899, **76**, ii, 356.
 11. Zts. physik. Chem. 1897, **23**, 299, 309, 316; abst. J. C. S. 1897, **72**, ii, 438.
 12. Zts. anal. Chem. 1889, **28**, 61; abst. Wag. Jahr. 1889, **35**, 599; J. C. S. 1889, **56**, 552; Bull. Soc. Chim. 1890, **3**, 567; Chem. Tech. Rep. 1888, **27**, II, 281; Chem. Centr. 1890, **61**, I, 781.
 13. E. P. 22351, 1895; abst. J. S. C. I. 1895, **14**, 1088; 1896, **15**, 695, 740.
 14. Gaz. chim. ital. 1894, **24**, II; abst. Zts. physik. Chem. 1895, **17**, 561.
 15. Zts. physik. Chem. 1898, **26**, 33; abst. J. C. S. 1898, **74**, ii, 427.
 16. E. P. 18802, 25069, 1899; abst. J. S. C. I. 1902, **21**, 364; J. Soc. Dyers Col. 1901, **17**, 30.
 17. J. C. S. 1899, **75**, 2; abst. Chem. Centr. 1899, **70**, I, 249.
 18. Proc. Roy. Soc. 1897, **61**, 358; abst. Chem. Centr. 1897, **68**, II, 564; Jahr. Chem. 1897, **50**, 574.
 19. Zts. physik. Chem. 1897, **23**, 566; J. C. S. 1897, **71**, 253.
 20. Zts. physik. Chem. 1895, **18**, 503; abst. J. C. S. 1896, **70**, ii, 236.
 21. Zts. physik. Chem. 1895, **18**, 473; abst. J. C. S. 1896, **70**, ii, 237; Jahr. Chem. 1895, **48**, 120; Chem. Centr. 1896, **67**, I, 187. Cf. J. C. S. 1895, **68**, ii, 154, 382.
 22. Zts. physik. Chem. 1899, **29**, 251; abst. J. C. S. 1899, **76**, ii, 634.
 23. F. P. 265607; abst. Jahr. Chem. 1897, **50**, 2818.
 24. Mon. Sci. 1897, **49**, 568; abst. Wag. Jahr. 1897, **43**, 982; J. Dist. 1897, **14**, 393; Chem. Centr. 1897, **68**, ii, 622; Jahr. Chem. 1897, **50**, 1143.
 25. Zts. physik. Chem. 1895, **17**, 138; Zts. anal. Chem. 1887, **26**, 356.
 26. E. P. 9521, 1896; abst. Chem. Ztg. 1897, **21**, 878; Mon. Sci. 1898,

M. Guerbet,¹ A. Brjunchonko,² R. Abegg and W. Seitz,³ R. Abegg,⁴ F. Adam,⁵ L. Andrews and C. Ende,⁶ J. Wakher,⁷ R. Willstätter,⁸ A. Wassiljeff,⁹ R. Wegscheider,¹⁰ I. Welt,¹¹ B. Zouboff,¹² L. Tschugaeff,¹⁴ M. Tsukamoto,¹¹ W. Tistschenko,¹⁵ S. Tereschin,¹⁶ G. Tammann,¹⁷ Silbermann,¹⁸ A. Shaw,¹⁹ W. Sagrebin,²⁰ W. Russell and W. Lapraik,²¹ W. Spring,²² A. Richardson and E. Fortey,²³ H. Richmond and P. O'Shaughnessy,²¹ A. Reychler,²⁵

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 26 Zts. physik. Chem. 1896, **19**, 179, Arch. sci. phys. nat. 1895, **33**, 409, 513
 27 Compt. rend. 1894, **119**, 906, abst. Chem. Centr. 1895, **66**, I, 151.
 1. Compt. rend. 1899, **128**, 511, 1002, 1908, **146**, 1405, J. Pharm. Chim. 1899, (6), **9**, 278, 1908, (6), **28**, 102, 1912, (7), **5**, 149, Bull. Soc. Chim. 1899, **21**, 487, 489, 1908, **3**, 1405, Pharm. J. 1899, 335, Chem. Centr. 1899, **70**, I, 728, **1403**, II, 20, Jahr. Chem. 1899, **52**, 882, 1905-1908, II, 2011; Proc. Amer. Pharm. Assoc. 1899, **47**, 694
 2. J. prakt. Chem. 1899, **167**, 45, abst. Zts. physik. Chem. 1899, **29**, 355.
 3. Zts. physik. Chem. 1899, **29**, 212, abst. J. C. S. 1899, **76**, n, 623.
 4. Ann. phys. 1897, **60**, 51, abst. J. C. S. 1897, **72**, n, 240
 5. Oesterr. Chem. Ztg. 1899, 241, abst. Zts. ang. Chem. 1899, **12**, 890, Wag. Jahr. 1899, **45**, 905, Chem. Centr. 1899, **70**, I, 1226
 6. Zts. physik. Chem. 1895, **17**, 137, 141, 144, abst. J. C. S. 1895, **68**, ii, 383
 7. J. prakt. Chem. 1899, **167**, 41, abst. Chem. Centr. 1899, **70**, I, 521, J. C. S. 1899, **76**, i, 323.
 8. U. S. P. 585610, 1897
 9. J. Russ. Phys. Chem. Soc. 1898, **30**, 963, abst. Jahr. Chem. 1898, **51**, 872
 10. Ber. 1895, **28**, 2535, abst. Chem. Centr. 1895, **66**, II, 1031
 11. Ann. Chim. Phys. 1895, (7), **6**, 115, abst. Chem. Centr. 1895, **66**, II, 635
 12. J. Russ. Phys. Chem. Soc. 1898, **30**, 926, Chem. Centr. 1899, **70**, I, 586, abst. J. C. S. 1899, **76**, n, 589
 13. Ber. 1898, **31**, 2451, abst. J. C. S. 1899, **76**, n, 3
 14. Chem. Centr. 1895, **66**, I, 657, abst. Jahr. Chem. 1895, **48**, 981
 15. J. A. C. S. 1897, **19**, 483, J. C. S. 1899, **76**, i, 408
 16. Zts. physik. Chem. 1897, **23**, 309, Wied. Ann. Phys. 1889, **36**, 792
 17. Ann. Phys. 1899, **68**, 553, 629, abst. J. C. S. 1899, **76**, n, 636
 18. Zts. physik. Chem. 1897, **23**, 308, 1899, **30**, 47
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 20. J. Russ. Phys. Chem. Soc. 1899, **31**, 19, abst. J. C. S. 1899, **76**, n, 735, Zts. physik. Chem. 1900, **32**, 640
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 23. J. C. S. 1896, **69**, 1349, abst. Jahr. Chem. 1896, **49**, 646; Chem. Centr. 1896, **67**, II, 777, Chem. News, 1896, **74**, 252, Bull. Soc. Chim. 1896, **16**, 2014; J. S. C. I. 1896, **15**, 919, Zts. physik. Chem. 1897, **22**, 650.
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 25. Bull. Soc. Chim. 1896, **15**, 970, abst. J. C. S. 1897, **72**, i, 549, Chem. Centr. 1896, **67**, II, 586.

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From 1901-1910 increased demand for amyl acetate caused increasingly acute shortages of amyl alcohol, and tended to heighten the zeal of investigators towards the synthetic formation of amyl alcohol by controllable fermentative processes, first accomplished in this decade. The advancement in amyl alcohol research and technology is embraced in the contributions of M. Konowalow,⁸ G. Just,⁹ A. Kailah,¹⁰ E. Knoevenagel and C. Bueckel,¹¹ J. Danziger,¹² K. Drucker,¹³ E. Blaise,¹⁴ L. Bouveault and G. Blanc,¹⁵ F. de Brandel and A. de B. de Asson,¹⁶ G. Ciamician¹⁷

¹ Zts. physik. Chem. 1896, **19**, 99, 108, 111, abst. J. C. S. 1896, **70**, ii, 288.

² Ber. 1897, **30**, 2784, abst. J. C. S. 1898, **74**, i, 116. J. Russ. Phys. Chem. Soc. 1899, **31**, 43, abst. Chem. Centr. 1899, **70**, i, 1066, J. C. S. 1899, **76**, i, 937.

³ J. Russ. Phys. Chem. Soc. 1898, **30**, 926, abst. Zts. physik. Chem. 1899, **29**, 752.

⁴ J. Russ. Phys. Chem. Soc. 1898, **30**, 900, abst. Chem. Centr. 1899, **70**, i, 591, J. C. S. 1899, **76**, i, 729.

⁵ Zts. physik. Chem. 1897, **24**, 18, 35, abst. Jahr. Chem. 1897, **50**, 243, Chem. Centr. 1897, **68**, II, 825, J. C. S. 1898, **74**, ii, 10.

⁶ Rec. trav. Chim. Pays-Bas, 1898, **17**, 27, abst. J. C. S. 1898, **74**, i, 506.

⁷ J. prakt. Chem. 1896, **161**, 257, abst. Chem. Centr. 1896, **67**, I, 1222. J. Russ. Phys. Chem. Soc. 1901, **33**, 143, 1902, **34**, 182, 315, 1903, **35**, 577, 592, 1907, **39**, 681, 693, Ber. 1901, **34**, 596, 1902, **35**, 1047, 1057, 1903, **36**, 1990, 2003, 1907, **40**, 90, 1281, abst. Chem. Centr. 1901, **72**, I, 826, 1902, **73**, I, 973, 1903, **74**, II, 335, Chem. Zentr. 1907, **78**, I, 1721, II, 2035. J. C. S. 1896, **70**, i, 401. Jahr. Chem. 1901, **54**, 606, 1902, **55**, 741, 1903-1908, II, 173. See also W. Ipatjew and W. Sdzitowiecky, Ber. 1907, **40**, 1827, abst. Chem. Zentr. 1907, **78**, II, 133, J. C. S. 1907, **92**, i, 45. W. Ipatjew and V. Wittorf, J. prakt. Chem. 1897, **163**, I, abst. J. C. S. 1897, **72**, i, 233.

⁸ J. Russ. Phys. Chem. Soc. 1901, **33**, 48, abst. Jahr. Chem. 1901, **54**, 619.

⁹ Zts. physik. Chem. 1901, **37**, 354, abst. J. C. S. 1901, **80**, ii, 439.

¹⁰ Wien. Akad. Ber. **112**, 381, Monatsh. 1903, **24**, 533, abst. J. C. S. 1903, **84**, i, 786, J. S. C. I. 1903, **22**, 1098, Bull. Soc. Chim. 1904, **32**, 554, Chem. Centr. 1903, **74**, II, 869, Jahr. Chem. 1903, **56**, 754, Wag. Jahr. 1904, **50**, II, 6, Zts. ang. Chem. 1903, **16**, 754, Essig. Ind. 1904, **8**, 325.

¹¹ Ber. 1901, **34**, 3993, abst. Chem. Centr. 1902, **73**, I, 187, Jahr. Chem. 1901, **54**, 1343.

¹² J. A. C. S. 1902, **24**, 578, abst. Jahr. Chem. 1902, **55**, 613, Chem. Centr. 1902, **73**, II, 478, Bull. Soc. Chim. 1903, **30**, 527, J. C. S. 1902, **82**, ii, 533.

¹³ Zts. physik. Chem. 1901, **36**, 211, abst. J. C. S. 1901, **80**, ii, 230, 376.

¹⁴ Bull. Soc. Chim. 1903, **29**, 327, abst. Chem. Centr. 1903, **74**, I, 1226, Jahr. Chem. 1903, **56**, 824, J. C. S. 1903, **84**, i, 507.

¹⁵ Compt. rend. 1903, **137**, 328, abst. J. C. S. 1903, **84**, i, 597, 693; Chem. Centr. 1903, **74**, II, 711, Bull. Soc. Chim. 1903, **29**, 787. Bull. Soc.

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 5. J C S 1907, **91**, 1728, 1908, **93**, 1815, 1909, **95**, 1556, 1559, abst Chem Zentr 1907, **78**, II, 2060, 1909, **80**, I, 155, II, 1979
 6. Ber. 1909, **42**, 1072, abst Chem Zentr 1909, **80**, I, 1550
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 8. J C S 1905, **87**, 265, 1906, **89**, 311, abst Chem Centr. 1905, **76**, 1097, 1315, 1906, **77**, I, 1087, Bull Soc Chim 1906, **36**, 2, 1218, Jahr Chem 1905-1908, II, 10, 1438
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 12. Compt. rend. 1907, **145**, 437, abst J C S 1907, **92**, i, 817
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- 8 Zts Chem Apparatenkunde **3**, 165, abst Chem Zentr 1908, **79**, I, 2002
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including the firm of Chem. Fabrik auf Actien, vorm E. Schüring.¹

• From 1911 to the present time the scarcity of amyl alcohol has been growing more acute, and the cost advancing correspondingly. The decreased production of spiritous liquors has heightened the acuteness of the situation, especially as the use of nitrocotton in high-boiling solvents as amyl acetate is continually extending. Among the later contributions to the subject are those of T. Johnson and H. Guest,² T. Komnenos,³ C. Krug and H. Bollert,⁴ H. Kiliani,⁵ A. Kling,⁶ A. Landolt,⁷ A. Doroszewski,⁸ K. Drucker and R. Kassel,⁹ L. Bloch,¹⁰ Chem. Werke vorm. Dr. H. Byk,¹¹ M. Brillouin,¹² P. Browning and S. Kuzirian,¹³ C. Cheneveau,¹⁴ H. Coupin,¹⁵ A. Fernbach and E. Strange,¹⁶ O. Faust and G. Tamman,¹⁷ F. Fontein,¹⁸ Badische

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8 J Russ Phys Chem Soc 1911, **43**, 66, abst Chem Zentr 1911, **82**, I, 1407.

9 Zts physik Chem 1911, **76**, 370, abst Chem Zentr 1911, **82**, I, 1395.

10 Compt rend 1910, **150**, 694, abst Chem Zentr 1910, **81**, I, 2054, J C S 1910, **98**, ii, 381, Ann Chim Phys 1911, **23**, 77, 91, 130, abst Chem Zentr 1911, **82**, I, 782.

11 D. R. P. 226228, abst Chem Zentr 1910, **82**, II, 1174, Zts ang Chem 1910, **23**, 2230. In this connection see F. Remfry, J C S 1911, **99**, 625, abst Chem Zentr 1911, **82**, I, 1739.

12 Ann Chim Phys 1909, **18**, 209, abst Chem Zentr 1910, **81**, I, 2.

13 Eighth Inter Cong Appl Chem 1912, **1**, 87.

14 Ann Chim Phys 1907, **12**, 145, abst Chem Zentr 1907, **78**, II, 1206, Phil Mag 1910, **20**, 357, abst Chem Zentr 1910, **81**, II, 1115.

15 Compt rend 1910, **151**, 1066, abst Chem Zentr 1911, **82**, I, 402.

16 U. S. P. 1044368, 1044446, 1044447, 1912, E. P. 15203, 15204, 16925, 1911, F. P. 448364, abst C A 1913, **7**, 206, J S C I 1912, **31**, 1091, 1143, 1913, **32**, 377, Mon Sci. 1913, **78**, 111, 112, Chem Ztg Rep 1913, **37**, 17.

17 Zts physik Chem 1910, **71**, 51, abst Chem Zentr 1910, **81**, I, 1091, J C S 1910, **98**, ii, 189, Bull. Soc Chim 1911, **10**, 227.

18 Zts physik. Chem 1910, **73**, 237, abst J C S 1910, **98**, ii, 596, Bull. Soc Chim 1912, **10**, 499, Chem Zentr. 1910, **81**, II, 267.

Anilin- und Sodafabrik,¹ F. Bartelli and L. Stern,² D. Berthelot and H. Gaudechon,³ E. Bingham,⁴ C. Gates,⁵ R. Goldsmith,⁶ O. Gros,⁷ V. Grignard and L. Zorn,⁸ F. Eisenlohr,⁹ J. Amann,¹⁰ H. v. Wyss, E. Herzfeld and O. Rewidzoff,¹¹ Akt. Ges. für Anilinfabrikation,¹² O. Warburg,¹³ I. Traube,¹⁴ J. Timmermann,¹⁵ K. Taipale,¹⁶ E. Scandallo,¹⁷ J. Senderens,¹⁸ F. Schwes, ¹⁹ E. Schmidt,²⁰ J. Scheckenbach,²¹ L. Rosenthaler,²² A. Richard,²³ A. Mueller,²⁴ L.

1. E. P. 10826, 1911; abst. J. S. C. I. 1912, **31**, 605; C. A. 1912, **6**, 3026. E. P. 17291, 1911; abst. C. A. 1913, **7**, 399; J. S. C. I. 1912, **31**, 410. E. P. 19764, 1912; abst. C. A. 1914, **8**, 554; J. S. C. I. 1913, **32**, 550. E. P. 18653, 1912; abst. J. S. C. I. 1913, **32**, 842; C. A. 1914, **8**, 553. F. P. 451315; abst. Chem. Ztg. 1913, **37**, 336. D. R. P. 258555; abst. Chem. Ztg. 1913, **37**, 358, Wag. Jahr 1913, **59**, II, 11; Chem. Ztg. Rep. 1913, **37**, 249; Zts. ang. Chem. 1913, **26**, II, 292; C. A. 1913, **7**, 2836. Aust. P. 62283, 1913. Belg. P. 251814, abst. Chem. Ztg. 1913, **37**, 254. Span. P. 54469; abst. Chem. Ztg. 1913, **37**, 228.
2. Biochem. Zts. 1910, **28**, 163; abst. Chem. Zentr. 1910, **81**, II, 1621.
3. Compt. rend. 1910, **151**, 1350; abst. Chem. Zentr. 1911, **82**, I, 636.
4. Amer. Chem. J. 1910, **43**, 292, 306; abst. J. C. S. 1910, **98**, ii, 395, Bull. Soc. Chim. 1911, **10**, 370, Chem. Zentr. 1910, **81**, I, 2051.
5. J. Phys. Chem. 1911, **15**, 97; abst. Chem. Zentr. 1911, **82**, I, 1481.
6. Physik. Zts. **12**, 417; abst. Chem. Zentr. 1911, **82**, II, 344.
7. Arch. exp. Pathol. u. Pharmac. **62**, 38, abst. Chem. Zentr. 1910, **81**, I, 1983.
8. Compt. rend. 1910, **150**, 1178; abst. Chem. Zentr. 1910, **81**, II, 143.
9. Zts. physik. Chem. 1911, **75**, 590, abst. Chem. Zentr. 1911, **82**, I, 625; Bull. Soc. Chim. 1911, **10**, 1221, J. C. S. 1911, **100**, ii, 81.
10. Zts. Chem. Ind. Kolloide, 1911, **8**, 197; abst. Chem. Zentr. 1911, **82**, I, 1676, C. A. 1911, **5**, 2459, J. C. S. 1911, **100**, ii, 388.
11. Zts. physiol. Chem. 1910, **64**, 479; abst. C. A. 1911, **5**, 1459, J. C. S. 1910, **98**, ii, 462, 571, J. S. C. I. 1910, **29**, 445, Drug. Circ. 1910, **54**, 627, Chem. Zentr. 1910, **81**, I, 1385, Jahr. Chem. 1910, **63**, II, 97.
12. Belg. P. 259277, abst. Kunst. 1914, **4**, 238.
13. Zts. physiol. Chem. **69**, 459, abst. Chem. Zentr. 1911, **82**, I, 336.
14. Biochem. Zts. 1910, **24**, 333, abst. Chem. Zentr. 1910, **81**, I, 2124.
15. Bull. Soc. chim. Belg. 1911, **25**, 300; abst. Chem. Zentr. 1911, **82**, II, 1015.
16. J. prakt. Chem. 1910, **190**, 47, abst. Chem. Zentr. 1910, **81**, II, 1130.
17. Boll. Soc. medico-chirurgica di Pavia, 1910; abst. Chem. Zentr. 1910, **81**, II, 543.
18. Compt. rend. 1913, **156**, 1909; abst. J. S. C. I. 1913, **32**, 767.
19. Rec. trav. Chim. Pays-Bas, 1910, **29**, 343; abst. Zts. physik. Chem. 1911, **75**, 360, 362, Chem. Zentr. 1910, **81**, II, 1582, 1793; 1911, **82**, I, 449, 450, 958, 1783.
20. Zts. physik. Chem. 1911, **75**, 305, abst. Chem. Zentr. 1911, **82**, I, 614.
21. F. P. 462472, 1913; abst. J. S. C. I. 1914, **33**, 329, C. A. 1914, **8**, 3221.
22. Zts. Nahr. Genuss. 1910, **20**, 453, abst. Chem. Zentr. 1910, **81**, II, 1506. See also E. Rupp, Zts. Nahr. Genuss. **13**, 74; abst. Chem. Zentr. 1907, **78**, I, 846. B. Kuhn and F. Bengen, Zts. Nahr. Genuss. **12**, 149; abst. Chem. Zentr. 1906, **77**, II, 1022.
23. Ann. Chim. Phys. 1910, **21**, 335, abst. C. A. 1910, **4**, 2303; J. C. S. 1910, **98**, i, 462; Chem. Zentr. 1911, **82**, I, 60; Bull. Soc. Chim. 1910, **7**, 459.
24. Arb. Kais. Gesundheitsamt **34**, 182; abst. Chem. Zentr. 1910, **81**, II, 677.

Michiels,¹ H. Merczwynig,² E. Merck,³ A. McDaniel,⁴ Vereinigte Chininfabriken Zimmer & Co.,⁵ H. Stadler,⁶ J. Mathews,⁷ E. I. du Pont de Nemours Powder Co.,⁸ W. Masland,⁹ A. Maille,¹⁰ C. Mariller,¹¹ H. Malosse,¹² R. Pickard, J. Kenyon and T. Lowry,¹³ W. Perkin, C. Weizmann and H. Davies,¹⁴ W. Perkin, C. Weizmann, F. Matthews and E. Strange,¹⁵ M. Padoa and L. Mervin,¹⁶ H. Pauly,¹⁷ J. Parnass,¹⁸ B. Oddo,¹⁹ A. Oxley,²⁰ G. Heyl and T. Baker,²¹ P. Hoeckendorf,²² U. Hoflander,²³ J. Holmes and P. Sageman,²⁴ H. Holländer,²⁵ A. Hantzsch,²⁶ R. Leiser,²⁷ A. Lasserre,²⁸ J.

- 1 Bull Acad roy Belg 1912, 22, abst C A 1912, **6**, 1611
- 2 Compt rend 1909, **149**, 981, abst Chem Zentr 1910, **81**, I, 598
- 3 J Russ Phys Chem Soc 1910, **42**, phys part, 264; abst Chem Zentr 1910, **81**, II, 857
- 4 E P 159, 1913, abst J S C I 1913, **32**, 768
- 5 J Phys Chem 1911, **15**, 587, abst Chem Zentr 1911, **82**, II, 666
- 6 E P 14699, 1911, abst J S C I 1912, **31**, 410
- 7 Arch Hyg **73**, 195, abst Chem Zentr 1911, **82**, I, 1071
- 8 J A C S 1911, **33**, 1291, abst Chem Zentr 1911, **82**, II, 1412
- 9 E P 29064, 1912, abst J S C I 1914, **33**, 375
- 10 U S P 1086381, 1914, assigned to E I du Pont de Nemours Co., abst C A 1914, **8**, 1330
- 11 Chem Ztg 1910, **34**, 1173, 1182, 1201, abst Chem Zentr 1911, **82**, I, 11
- 12 Bull Assoc Chim. de Sucre et Dist **28**, 473, abst Chem Zentr 1911, **82**, I, 1184
- 13 Compt rend. 1911, **154**, 1697; abst J C S 1912, **102**, i, 636
- 14 Ann Chim Phys 1910, **21**, 323, J C S 1911, **99**, 49, 59, 65; 1912, **101**, 624, 627, 630, abst J C S 1911, **100**, i, 6, Chem Zentr 1911, **82**, I, 713
- 15 E P 277, 1912, abst J S C I 1913, **32**, 212, Chem Ztg Rep 1913, **37**, 168, C A 1912, **6**, 2095
- 16 E. P 5931, 5932, 1910, U. S. P. 991453, abst J S C I 1911, **30**, 833, 909; C A 1911, **5**, 3324, 3347, Chem Ztg Rep 1911, **35**, 450, Mon. Sci 1913, **78**, 450, 455, 1915, **82**, 76 E. P 9721, 1911, abst J Soc Dyers Col 1912, **28**, 247; J S C I 1912, **31**, 511, C A 1912, **6**, 2840
- 17 Gaz. chim ital 1911, **41**, I, 198, abst Chem Zentr 1911, **82**, II, 3.
- 18 Ann 1911, **383**, 265, abst Chem Zentr. 1911, **82**, II, 1332
- 19 Biochem. Zts 1910, **28**, 289, abst Chem. Zentr 1910, **81**, II, 1668.
- 20 Gaz chim ital. 1911, **41**, I, 288, abst Chem Zentr 1911, **82**, I, 1855
- 21 Proc Cambridge Phil Soc **16**, 102, abst Chem Zentr. 1911, **82**, I, 1178
- 22 E P 10055, 1913; abst C A 1914, **8**, 3507, J S C I 1914, **33**, 604
- 23 Biochem Zts 1909, **23**, 298; abst Chem Zentr 1910, **81**, I, 947
- 24 Boll. chim farm. **51**, 223, abst C. A. 1912, **6**, 3307.
- 25 J C. S. 1909, **95**, 1919, abst. Chem. Zentr 1910, **81**, I, 319
- 26 Munch. med. Wochschr **57**, 82, abst Chem Zentr 1910, **81**, I, 671, Drug. Circ. 1910, **54**, 275; Jahr Chem 1910, **63**, II, 97. Zts Nahr Genuss. **21**, 280; abst. Chem. Zentr 1911, **82**, I, 1327. Boll. chim. farm. 1913, **52**, 5; abst. C. A 1915, **9**, 2041.
- 27 Ann. 1911, **384**, 135; abst. Chem. Zentr. 1911, **82**, II, 1697.
- 28 Abhandl. Deut. Bunsen Ges. 1910, No. 4; abst. Chem Zentr 1911, **82**, I, 624.
- 29 Ann. Chim. anal. 1910, **15**, 338; abst. J. C. S. 1910, **98**, ii, 1005.

Loeb,¹ G. Keyes and W. Winninghoff,² H. Curtis and R. Burns,³ R. Adams, O. Kamm and C. Marvel,⁴ E. Anderson,⁵ F. Matthews⁶ and H. Elder,⁶ Neumann & Co.,⁷ A. Hollande,⁸ G. Heinzelmann,⁹ and A. Hamsik.¹⁰

An interesting development in connection with attempts to synthesize amyl alcohol so as to convert it into the corresponding ester has been the series of investigations in the halogenation of the pentanes from petroleum. In the chlorination of these aliphatic hydrocarbons, the methods of E. du Pont and associated chemists,¹¹ H. Hibbert¹² and W. Masland,¹³ F. Kaufler,¹⁴ E. Schering,¹⁵ Badische Anilin u. Soda Fabrik,¹⁶ C. Mabery and E. Hudson,¹⁷

1. Biochem. Zts. 1909, **23**, 94, abst. Chem. Zentr. 1910, **81**, I, 942
2. J. A. C. S. 1916, **38**, 1178, abst. C. A. 1916, **10**, 1724.
3. J. A. C. S. 1917, **39**, 33, abst. J. S. C. I. 1917, **36**, 214
4. J. A. C. S. 1918, **40**, 1950, abst. J. S. C. I. 1919, **38**, 599-A; C. A. 1919, **13**, 312
5. J. Phys. Chem. 1916, **20**, 195, abst. J. S. C. I. 1916, **35**, 478; Ann. Rep. Soc. Chem. Ind. 1916, **1**, 167
6. E. P. 11635, 1914, abst. J. S. C. I. 1915, **34**, 670; Ann. Rep. Soc. Chem. Ind. 1916, **1**, 192.
7. F. P. 466804, 1913; abst. C. A. 1915, **9**, 1370, Mon. Sci. 1916, **83**, 14, Chem. Ztg. Rep. 1914, **38**, 581
8. Compt. rend. Soc. de biologie, 1918, **81**, 223, abst. Chem. Zentr. 1919, **90**, II, 316, C. A. 1919, **13**, 851
9. Zts. Spiritusind. 1913, **36**, 14, abst. Chem. Zentr. 1913, **84**, I, 968, Zts. ang. Chem. 1913, **26**, II, 330, C. A. 1913, **7**, 2649, J. S. C. I. 1913, **32**, 155
10. Zts. physiol. Chem. 1911, **71**, 245, abst. Chem. Zentr. 1911, **82**, I, 1521.
11. U. S. P. 1077988, 1082543, 1913, 1086381, 1914; 1148258, 1915, 1261811, 1266073, 1918, abst. J. S. C. I. 1913, **32**, 1128, 1915, **34**, 924; 1918, **37**, 349-A, 461-A, C. A. 1915, **9**, 2593. E. P. 29961, 29963, 1912; 879, 1913; 119249, 1917, 122456, 1918; abst. C. A. 1914, **8**, 210, 2253, 1919, **13**, 134; J. S. C. I. 1914, **33**, 502, 1919, **38**, 170-A. Can. P. 147425, 1913; abst. C. A. 1913, **7**, 2096. Belg. P. 253128, 1913
12. U. S. P. 1158217, 1915; abst. J. S. C. I. 1915, **34**, 1225. See P. Guye and A. do Armal, Arch. sci. phys. nat. 1895, **33**, 409, 513; abst. Zts. Chem. 1896, **19**, 179.
13. U. S. P. 1095013, 1912, abst. C. A. 1914, **8**, 2219; J. S. C. I. 1914, **33**, 844. Cf. J. Simon-Thomas, Rev. inter. fals. 1899, **12**, 82; abst. Chem. Zentr. 1899, **70**, II, 219
14. E. P. 2779, 3133, 1913, abst. J. S. C. I. 1913, **32**, 767, 885; Chem. Ztg. 1913, **37**, 1321. F. P. 545275, 1913, abst. C. A. 1914, **8**, 211; J. S. C. I. 1913, **32**, 885, Mon. Sci. 1914, **81**, 10, Chem. Ztg. 1913, **37**, 628. D. R. P. 274202, 1913; abst. Kunst. 1914, **4**, 235. Aust. Ann. 830, 1913; abst. Chem. Ztg. 1913, **37**, 1489. Aust. P. 59478, 1913, 64979, 1914, abst. Chem. Ztg. 1913, **37**, 596, 684
15. D. R. P. Ann. C-20497, 1911, abst. Chem. Ztg. 1912, **36**, 775. F. P. 441278, 1912; abst. Chem. Ztg. 1912, **36**, 901. See J. Trambics, Zts. Nahr. Genuss. 1917, **34**, 467, abst. C. A. 1920, **14**, 794.
16. U. S. P. 1098858, 1914; abst. J. S. C. I. 1914, **33**, 807. E. P. 19764, 1912, abst. J. S. C. I. 1913, **33**, 550; Chem. Ztg. 1913, **37**, 567. Aust. P. Ann. 10273, 1912; abst. Chem. Ztg. 1913, **37**, 881. Aust. P. 62283, 1913;

Meister, Lucius u. Brüning,¹ and B. Brooks, D. Smith and H. Essex² are illustrative. The general method was to isolate isopentane by fractional distillation of petroleum hydrocarbons, this being chlorinated into isopentyl chloride, which then easily esterifies into the corresponding acetate (isoamyl acetate). However, in manufacture the process was found not so simple as might appear. An immense amount of money has been expended on this subject in the United States within the past few years, and with not very satisfactory results.

It will be remembered that many of the syntheses of artificial caoutchouc employed amyl alcohol, and that an abundance of this alcohol at a low price would find its employment in large amounts not only as a rubber solvent, but in the synthesis of rubber as well.

Fusel Oil. In the period before 1850 appeared the earlier, and fundamental researches on fusel oil of Scheele,³ A. Gehlen,⁴ G. Mulder,⁵ H. Aubergier,⁶ W. Stein,⁷ G. Pelletan,⁸ Moldenhaur,⁹

abst Chem Ztg 1913, **37**, 1423. Ital P 398 110 130361, abst Chem Ztg 1913, **37**, 1009. Holl P 1813, 1912, abst Chem Ztg 1913, **37**, 1321. Swiss P 61918, 1912, abst Chem Ztg 1913, **37**, 1277.

17 Amer Chem J 1897, **19**, 243, abst Chem Centr 1897, **68**, 1, 967. See also Hung Ann W 3183, 1911, abst Chem Ztg 1912, **36**, 88.

18 D R P 308043, 1914. For synthetic amyl acetate and its homologues prepared by the esterification of chloro-hydrocarbons of the olefine or naphthene series, see G. Oberfell and H. Boyd, U. S. P. 1278198, 1918, abst C A 1918, **12**, 2325, J S C I 1918, **37**, 783-A. U. S. P. 1302583, 1919, abst C A 1919, **13**, 1863, J S C I 1919, **38**, 551-A, J C S 1919, **116**, 1, 465, Chim Ind 1920, **3**, 217.

19 J Ind. Eng. Chem 1918, **10**, 511, abst C A 1918, **12**, 2436, J S C I 1918, **37**, 530-A. W. Perkin and C. Weizmann, E. P. 277, 1912. H. Jahn and G. Moller, Zts. physik Chem 1894, **13**, 385.

20 Crell Ann 1785, **1**, 61.

21 Schweigger, Beitrage zur Chemie und Physik, 1811, **1**, 277.

22 Pogg Ann 1812, **41**, 582, 1837, **41**, 359, abst Berz Jahr Chem 1839, **18**, 403, Pogg Ann 1837, **41**, 582, abst Berz Jahr Chem 1839, **18**, 338, **23**, 456, Pogg Ann 1837, **41**, 587, abst Berz Jahr Chem 1839, **18**, 314. Ann 1843, **45**, 67, abst Chem Centr 1845, **16**, 223. See also Ann 1837, **24**, 245, Natuur en Scheikund Archief **5**, 105. Scheikundige Verhandelingen en Onderzoekingen **2**, 1, 100, abst Jahr Chem 1858, **11**, 302.

23 Ann Chim Phys. 1820, (2), **14**, 210.

24 Dmgl Poly 1824, **13**, 429. Poly Centr 1859, **25**, 1627, Dmgl 1860, **155**, 22, Poly Notizbl. 1860, **15**, 37, Wag. Jahr 1859, **5**, 404, Chem Centr. 1860, **31**, 109.

25 Ann. Chim. Phys 1825, (2), **30**, 221, abst J Chim Med **1**, 76, Berz. Jahr. Chem. 1827, **6**, 264; N. pr **1**, 135.

26 Geigers Mag. **31**, 222, abst Chem Centr 1830, **1**, 542. Berz Jahr. Chem. 1832, **11**, 301. See also W. Zeise, Tromsd. N. J. Pharm 1823 **7**, 1, 145; Orsted Tidsskrift, 1822, **1**, 238.

Mayr,¹ F. Goebel,² L. Hünefeld,³ Schwacke,⁴ C. Chryselius,⁵ Wilke,⁶ J. Joss,⁷ H. Brandes,⁸ J. Dumas,⁹ A. Fischer,¹⁰ A. Laurent,¹¹ A. Cahours,¹² J. Dumas and J. Stas,¹³ C. Gerhart and A. Cahours,¹⁴ E. Witting and L. Buchner,¹⁵ A. Balard,¹⁶ J. Apjohn,¹⁷ G. de Claubry,¹⁸ H. Kolbe,¹⁹ Deschamp,²⁰ Zachau,²¹ C. Glassford,²² L. de Koninck,²³ J. Doebereiner,²⁴ Xalhau,²⁵ J. Trautwein,²⁶ W. Knop,²⁷

1. Brandes Arch. **32**, 249, abst. Chem Centr. 1830, **1**, 112
2. Erdm. J. Tech. Chem. 1831, **12**, 91, Schweigg. J. 1831, **63**, 225; abst. Chem. Centr. 1831, **2**, 639. N. Jahr. Chem. Pharm. 1831, **3**, 225; abst. Berz. Jahr. Chem. 1833, **17**, 283
3. Erdm. J. Tech. Chem. 1831, **11**, 327, abst. Chem Centr. 1831, **2**, 685.
4. Brandes Arch. **38**, 202, abst. Chem Centr. 1831, **2**, 579
5. Erdm. J. Tech. Chem. 1831, **12**, 351; abst. Chem Centr. 1831, **2**, 748, 826, 1832, **3**, 124
6. Berz. Jahr. 1834, **13**, 49, 321
7. Chem. Centr. 1834, **5**, 192
8. Chem. Centr. 1834, **5**, 141
9. Ann. Chim. Phys. 1834, (2), **54**, 314, Ann. 1835, **13**, 80, J. chim. méd. **10**, 705; Pogg. Ann. 1835, **34**, 335, Ann. 1835, **35**, 143, Berz. Jahr. Chem. 1836, **15**, 313, J. prakt. Chem. 1835, **3**, 321, Chem. Centr. 1835, **6**, 358, 1840, **11**, 633.
10. A. Fischer, Ann. 1861, **118**, 307. See Ann. 1836, **19**, 241
11. Ann. Chim. Phys. 1836, **43**, 377, J. prakt. Chem. 1837, **11**, 232, Ann. 1837, **22**, 202, abst. Chem Centr. 1837, **8**, 199, 525. Ogent. Notizen, 1837, 3.
12. Institut 1837, 69, abst. J. prakt. Chem. 1837, **10**, 268, Berz. Jahr. Chem. 1839, **18**, 337, Compt. rend. 1837, **4**, 341, Chem. Centr. 1839, **10**, 223, Compt. rend. 1838, **6**, 656, abst. Berz. Jahr. Chem. 1840, **19**, 489, J. prakt. Chem. 1839, **17**, 213, abst. Berz. Jahr. Chem. 1839, **18**, 516, Ann. Chim. Phys. 1839, (2), **70**, 81, Ann. 1838, **30**, 288, Chem. Centr. 1839, **10**, 426, Ann. Chim. Phys. 1840, **75**, 193, 202, abst. Berz. Jahr. Chem. 1842, **21**, 439, 441, 1846, **25**, 776; J. prakt. Chem. 1841, **22**, 171, Chem. Centr. 1840, **11**, 829; 1841, **12**, 227, 245, Ann. 1840, **35**, 312, 1841, **37**, 164
13. Ann. 1840, **35**, 143, abst. J. prakt. Chem. 1840, **21**, 278, Berz. Jahr. Chem. 1842, **21**, 440
14. Ann. 1840, **35**, 309, abst. Chem Centr. 1840, **11**, 829
15. Chem. Centr. 1841, **12**, 944. See also E. Witting, J. prakt. Chem. 1835, **6**, 1. L. Buchner, Dingl. Poly. 1846, **100**, 203
16. Ann. Chim. Phys. 1844, (3), **12**, 294. Compt. rend. 1844, **19**, 634. J. prakt. Chem. 1845, **34**, 123, Ann. 1844, **52**, 311, Berz. Jahr. Chem. 1846, **25**, 776
17. Phil. Mag. 1840, **17**, 86, abst. Berz. Jahr. Chem. 1842, **21**, 441.
18. Compt. rend. 1842, **15**, 171, abst. Chem Centr. 1845, **16**, 47, 481, Ann. 1842, **44**, 127, abst. Berz. Jahr. Chem. 1844, **23**, 457. J. prakt. Chem. 1842, **27**, 56
19. Ann. 1842, **41**, 53, abst. Berz. Jahr. Chem. 1844, **23**, 456, Chem. Centr. 1842, **13**, 60. See also G. Mulder, Pogg. Ann. 1837, **41**, 582, Ann. 1837, **24**, 248
20. Ann. Chim. Phys. 1844, (3), **12**, 383
21. Arch. Pharm. **39**, 31; abst. Chem Centr. 1844, **15**, 639
22. Ann. 1845, **54**, 104
23. Bull. Acad. Sci. Belg. **9**, II, 546, abst. Berz. Jahr. Chem. 1845, **24**, 552.
24. J. prakt. Pharm. **7**, 93; abst. Berz. Jahr. 1845, **24**, 551.
25. Dingl. Poly. 1846, **100**, 80.
26. Buchn. Rep. (2), **41**; abst. Chem. Centr. 1846, **17**, 326.
27. Chem. Centr. 1847, **18**, 687.

C. Person,¹ W. Peters,² A. Müller,³ and especially that of Meurer.⁴

In the decade 1850-1860 considerable experimentation is recorded on the question of the composition of fusel oil from different sources, and the nature of the alcohols and other bodies contained therein. Among the results disclosed appear the work of H. Fehling,⁵ H. Schroeder,⁶ T. Rowney,⁷ V. Faget,⁸ C. Wetherill,⁹ G. Chancel,¹⁰ S. Johnson,¹¹ F. Jeanjean,¹² N. Kent,¹³ A. Perrot,¹⁴ Kletzensky,¹⁵ H. Schwarz,¹⁶ A. Wurtz,¹⁷ F. Guthrie,¹⁸ J. Poynter,¹⁹

1. Compt rend 1846, **23**, 524, abst. L'Institut 1846, 302, Pogg Ann 1847, **70**, 386; Ann 1847, **64**, 185, Jahr Chem 1847 1848, **1**, 91.

2. Dingl. Poly 1848, **108**, 79, Arch Pharm (2), **53**, 335, Chem Centr 1848, **19**, 368; abst. Jahr Chem. 1847, **1**, 1111.

3. J. prakt Chem 1849, **46**, 108; abst. Jahr Chem 1851, **4**, 498. Poly Centr 1852, **18**, 1103. J. prakt Chem 1852, **56**, 103, abst. Jahr Chem 1852, **5**, 498. J. prakt Chem 1857, **70**, 68, abst. Wag. Jahr 1856, **2**, 258.

4. Chem Centr 1852, **3**, 794.

5. Ber. 29^{te} Versammlung (1852), Deut. Natur-Forscher und Aerzte, abst. Dingl. Poly 1853, **130**, 77, J. Pharm 1854, (3), **25**, 74. Jahr Chem. 1853, **6**, 441.

6. Pogg Ann 1850, **79**, 34, abst. Chem Centr 1850, **21**, 337, 352. See also Wied. Ann Phys 1882, **15**, 636, abst. Jahr Chem 1882, **35**, 174.

7. J. C. S. 1851, **4**, 372, 1852, **5**, 22, Ann 1851, **79**, 236, Edinb Phil Trans **20**, II, 219, J. prakt Chem 1851, **54**, 211, Chem Gaz 1852, **32**, Chem Centr 1851, **22**, 950, Jahr Chem 1851, **4**, 442. J. C. S. 1852, **5**, 22, abst. J. prakt Chem 1852, **56**, 246, Jahr. Chem 1852, **5**, 490.

8. Compt rend 1853, **37**, 730, abst. J. Pharm 1853, (3), **24**, 397. Arch. ph. Nat **24**, 387, Ann 1853, **88**, 325, Chem Centr 1854, **25**, 29, Jahr. Chem 1853, **6**, 504.

9. Chem Gaz 1853, **10**, 281, 441, abst. J. prakt Chem 1853, **60**, 202, Jahr. Chem 1853, **6**, 441.

10. Compt rend 1853, **37**, 410, abst. Institut 1853, 310, Arch. ph. Nat **24**, 385, J. prakt Chem 1853, **60**, 205, Chem Centr 1853, **24**, 824, Mem Acad 1855-1857, 111, 225.

11. J. prakt Chem 1854, **62**, 262, abst. Jahr Chem 1854, **7**, 445.

12. Compt rend 1856, **42**, 857, J. prakt Chem 1856, **69**, 204, Ann. 1857, **101**, 94, Poly. Centr 1856, **22**, 892, Chem Centr 1856, **27**, 575, 672, Jahr. Chem 1854, **7**, 625, Wag. Jahr 1856, **2**, 241, L'Institut 1856, 176, 260.

13. N. Y. J. Pharm. Dec 1852, abst. Am. J. Pharm 1852, **24**, 353.

14. Compt rend 1857, **45**, 309, abst. Ann 1858, **105**, 64, J. prakt. Chem 1858, **73**, 174, Jahr. Chem 1857, **10**, 352, Wag. Jahr 1858, **4**, 380. See also J. prakt. Chem. 1852, **56**, 103, Ann. Chim. Phys. 1854, (3), **42**, 129, abst. Ann 1855, **93**, 107. J. prakt. Chem 1855, **64**, 282, abst. Chem. Centr 1854, **25**, 727. J. prakt. Chem 1851, **54**, 211, 1853, **59**, 246; **60**, 202.

15. Neueste Erfindungen 1858, No. 14, Dingl. Poly. 1858, **148**, 150, Poly. Centr 1858, **24**, 1057, Poly. Notizbl 1858, **13**, 171; Chem Centr 1858, **29**, 591; Wag. Jahr 1858, **4**, 361.

16. Dingl. Poly 1858, **149**, 377, abst. Poly Centr 1859, **25**, 351, Verhandl. Niederoestr. Gewerbeverein, 1858, 411, Wag. Jahr. 1858, **4**, 380.

17. Ann. Chim. Phys. 1854, (3), **42**, 129, Ann. 1853, **85**, 197; 1855, **93**, 107; J. prakt. Chem 1855, **64**, 282; 1863, **90**, 235, Chem Centr. 1854, **25**, 727.

18. J. C. S. 1858, **11**, 245; 1859, **12**, 109; Ann 1860, **113**, 266; abst. Zts. ges. Natur. **14**, 217; Chem Centr. 1860, **31**, 405; Jahr. Chem. 1859, **12**, 484.

19. Lond. J. 1858, 264; Poly. Centr. 1859, **25**, 139.

Breton,¹ J. Fischer,² and including J. Thwaite and W. Herapath.³

From 1861 to 1870 appear the investigations of H. Reinsch,⁴ Vandavelde,⁵ Varrentrap,⁶ H. Hirsch,⁷ A. Martin,⁸ H. Kalisch,⁹ A. Hofmann,¹⁰ A. Borodin,¹¹ Bugowski,¹² Fritzsche,¹³ E. Dietrich,¹⁴ Tromsdorff,¹⁵ I. Pierre and E. Puchot,¹⁶ Y. de Schepper and P. Tak,¹⁷ A. Pedler,¹⁸ G. Krämer and A. Pinner,¹⁹ W. Morkownikoff,²⁰ J. Leuchs,²¹ F. Spilsbury and F. Emerson.²²

Especially in the ten years from 1871 to 1880, inclusive, the isomeric alcohols comprizing fusel oil, and the various esters and other bodies present therein in relatively small amounts, were

1. Genie Ind. 1858, 257, Dingl. Poly. 1858, **150**, 424; Poly. Notizbl. 1859, **14**, 74, Wag. Jahr. 1858, **4**, 362, 1859, **5**, 402.
2. E. P. 1278, 1859.
3. E. P. 2646, 1853.
4. Neues Jahr. Pharm. **13**, 353, abst. Chem. Centr. 1860, **31**, 1023.
5. Genie Industriel, 1860, 48, abst. Dingl. Poly. 1860, **157**, 240; Poly. Centr. 1860, **26**, 1424, Poly. Notizbl. 1860, **15**, 335; Hamn. Agronom. Zts. 1860, 782; Wag. Jahr. 1860, **6**, 423.
6. Dingl. Poly. 1860, **158**, 378, abst. Poly. Centr. 1861, **27**, 350, Wag. Jahr. 1860, **6**, 423.
7. N. Repert. Pharm. **10**, 294, abst. Dingl. Poly. 1861, **162**, 159, Poly. Centr. 1861, **27**, 1661, Poly. Notiz. 1861, **16**, 330, Wag. Jahr. 1861, **7**, 458; Wieg's Gwz. 1862, 127, Agron. Ztg. 1862, 348, Arch. Pharm. (2), **109**, 30; N. Jahr. Pharm. **17**, 40, Zts. Chem. 1862, **5**, 288; J. Pharm. 1861, (3), **40**, 507, Jahr. Chem. 1861, **14**, 609. Chem. Tech. Mitth. 1861-1862, 100. Wittstem's Vierteljahreschrift, **11**, 401, abst. Chem. Centr. 1863, **34**, 304. Poly. Centralh. 1861, No. 42.
8. E. P. 158, 1862.
9. Poly. Notizbl. 1862, **17**, 133, Bayer. Kunst u. Gewerbebl. 1863, 444, Wilda's Landwirtschaft. Centr. 1862, 520, Wag. Jahr. 1862, **8**, 499.
10. E. P. 1291, 1863.
11. J. prakt. Chem. 1864, **93**, 414, abst. Jahr. Chem. 1864, **17**, 338.
12. Annal. du Genie Civil 1865, 469, abst. Dingl. Poly. 1865, **178**, 244, Wag. Jahr. 1865, **11**, 532.
13. Zts. gesammte Naturwissenschaft 1865, 228; abst. Dingl. Poly. 1865, **176**, 245, Poly. Centr. 1865, **31**, 959, Poly. Notizbl. 1865, **20**, 144, Hess. Gewerbebl. 1865, 278, Deut. Ind. Ztg. 1865, 188, Wag. Jahr. 1865, **11**, 531.
14. Bayer. Kunst. Gewerbeblatt, 1867, 215, abst. Poly. Notizbl. 1867, **22**, 163, 185. Chem. Tech. Rep. 1867, I, 31.
15. Tageblatt Frank. Naturf. 1867, 62.
16. Compt. rend. 1868, **66**, 302, abst. Chem. Centr. 1868, **39**, 989.
17. Ann. Chim. Phys. 1871, (4), **22**, 234, abst. Chem. Centr. 1871, **42**, 611.
18. Zts. Chem. 1868, **4**, 520, abst. Jahr. Chem. 1868, **21**, 434, Bull. Soc. Chim. 1868, (2), **10**, 418, Chem. Centr. 1869, **40**, 883.
19. J. C. S. 1868, **21**, 74, abst. J. prakt. Chem. 1868, **104**, 382.
20. Ber. 1870, **3**, 77, abst. Jahr. Chem. 1870, **23**, 423; 1871, **24**, 505.
21. J. Russ. Phys. Chem. Soc. 1869, **1**, 242; Ber. 1869, **2**, 660; Zts. f. Chem. 1870, **13**, 29; abst. Jahr. Chem. 1869, **22**, 364.
22. Dingl. Poly. 1862, **166**, 240, abst. Wag. Jahr. 1862, **8**, 500.
22. E. P. 1232, 1862.

examined, details of which are to be found in the publications of F. Grimm,¹ D. Howard,² Bouvier,³ S. van Choate,⁴ C. Arnold,⁵ C. Widemann,⁶ C. Fleischmann,⁷ W. Schultze,⁸ N. Ley,⁹ G. Ulex,¹⁰ R. Boettger,¹¹ P. Toepler,¹² Dujardin-Beaumetz,¹³ H. Gutknecht,¹⁴ A. Freund,¹⁵ A. Fitz,¹⁶ A. Dupre,¹⁷ M. Zingler,¹⁸ F. Strohm-

- 1 Chem Tech Rep 1871, **10**, I, 42. Ann 1871, **157**, 261.
- 2 Chem News, 1871, **23**, 139, abst Chem Centr 1871, **42**, 323, Jahr Chem. 1871, **24**, 39.
- 3 Chem Tech Rep 1871, **10**, I, 139. Poly Notizbl 1865, **20**, 110, abst. Chem Centr 1871, **42**, 352. Zts. anal. Chem 1872, **11**, 343, abst. Proc Amer Pharm Assoc 1873, **21**, 337, Jahr Chem 1872, **25**, 920, J. C S 1873, **26**, 532.
- 4 S van Choate, E. P. 1801, 1870, abst. Ber 1871, **4**, 131, Wag. Jahr 1871, **17**, 647.
- 5 Pharm Zts Russ **10**, 401, abst. Chem Centr 1871, **42**, 712.
- 6 Mon Ser 1872, **14**, 783, abst. Wag. Jahr 1872, **18**, 508.
- 7 U. S. P. 136147, 1873.
- 8 Dingl. Poly 1872, **206**, 211, abst. Chem. News 1872, **26**, 301, Wag. Jahr 1873, **19**, 650.
- 9 H. Ley, Ber 1873, **6**, 1254, 1363.
- 10 Chem Tech Rep 1873, **12**, II, 217, Arch. Pharm. (3), **2**, 289, Chem Centr 1873, **44**, 376, Poly Centr 1873, **39**, 926, Dingl. Poly 1873, **208**, 370, J. Pharm. 1873, **33**, 333, Amer Chem 1873, **4**, 111, Wag. Jahr 1873, **19**, 648. Ber 1873, **6**, 600, abst. Dingl. Poly 1873, **209**, 467, Jahr Chem 1873, **26**, 953, Chem Tech Mitth 1872-1873, 111.
11. Poly Notiz 1873, **28**, 15, Dingl. Poly 1873, **207**, 516, Jahr Chem 1873, **26**, 953, Chem Centr. 1873, **44**, 103, Wag. Jahr 1873, **19**, 650, Deut. Ind. Ztg 1873, 184. Poly Centr 1873, **39**, 275, Chem Tech Mitth 1872-1873, 111.
- 12 E. P. 1123, 2745, 1870, abst. Ber 1871, **4**, 534, Poly Centr 1871, **37**, 864.
- 13 Compt. rend 1875, **81**, 631, abst. Chem Centr 1875, **46**, 807; Wag. Jahr 1875, **21**, 824, Chem. Tech Rep 1875, **14**, II, 82.
- 14 Ber 1879, **12**, 622, abst. Jahr Chem 1879, **32**, 1065, Chem Centr 1879, **50**, 402, Bull. Soc. Chim. 1880, **23**, 305. See also Jahr Chem 1871, **27**, 311, Chem Centr 1875, **46**, 18.
- 15 J. prakt. Chem 1875, **120**, 25, abst. Wag. Jahr 1875, **21**, 882, Chem Tech Rep 1875, **14**, II, 84.
- 16 Ber 1875, **8**, 631, abst. Bull. Soc. Chim. 1875, **24**, 415, Chem Centr 1875, **46**, 438; Jahr Chem. 1875, **28**, 429. Ber 1875, **8**, 1540, abst. Chem Centr 1876, **47**, 85, Bull. Soc. Chim. 1876, **26**, 47, Jahr Chem 1875, **28**, 898. Ber 1876, **9**, 1348; abst. Chem. Centr. 1876, **47**, 787, 1877, **48**, 261, Bull. Soc. Chim. 1877, **28**, 24, 1878, **29**, 472, Jahr. Chem 1876, **29**, 343. Ber 1876, **9**, 1352, abst. Chem Centr. 1876, **47**, 78, Bull. Soc. Chim 1877, **28**, 24, 26, Jahr Chem. 1876, **29**, 950. Proc. Chem Soc **26**, 228, abst. Jahr Chem 1877, **30**, 1019. Ber 1877, **10**, 2226, abst. Jahr Chem 1877, **30**, 1021. Ber. 1878, **11**, 42, abst. Dingl. Poly 1878, **228**, 557, abst. Chem Centr 1878, **49**, 18, Jahr. Chem 1878, **31**, 703. Ber 1878, **12**, 42, 1890, abst. Bull. Soc. Chim 1880, **33**, 189, Jahr Chem. 1878, **31**, 1017. Ber 1879, **13**, 474, abst. Chem. Centr. 1879, **50**, 343, Bull. Soc. Chim 1880, **33**, 189, Jahr. Chem. 1879, **32**, 1012. Ber. 1880, **14**, 36, abst. Jahr. Chem. 1880, **33**, 605. Ber 1880, **14**, 1312, abst. Chem Centr 1880, **51**, 483, Bull. Soc. Chim 1881, 270, Jahr Chem. 1880, **33**, 1131. Ber 1881, **14**, 1054, Chem. Centr 1880, **51**, 422, Bull. Soc. Chim. 1881, **36**, 655, Jahr Chem 1881, **34**, 660, 721. Ber. 1882, **15**, 867, abst. Chem Centr 1882, **53**, 3, Bull. Soc.

mer,¹ A. Rabuteau,² A. Wischnegradsky,³ W. Cronquist,⁴ F. Filsinger,⁵ H. Schrötter,⁶ A. Hofmann and K. Reifner,⁷ J. Freeman,⁸ A. Jorissen,⁹ S. Roessler,¹⁰ H. Briem,¹¹ J. Noad,¹² and W. Pitchford.¹³

The use of amyl acetate was patented during the eighties, as a nitrocellulose solvent, and this greatly stimulated interest in fusel oil as the source for this ester, so that whereas in previous years fusel oil had been considered as a troublesome and worthless impurity, the demand began to increase. Enhanced interest in the practical side of the subject, as evidenced from a perusal of the work of H. Hager,¹⁴ Muller,¹⁵ K. Foerster,¹⁶ L. Haitinger,¹⁷

Chim 1882, 584; Jahr. Chem 1882, **35**, 1249

17. Pharm. J. Trans (3), **6**, 867; abst. J. C. S. 1876, **30**, 215; Jahr Chem. 1876, **29**, 1009

18. E. P. 215, 1876.

1. Organ Central Ver. Rubenzucker. Ind in Oest. Ungar. 1877, 71; abst. Wag. Jahr. 1877, **23**, 808.

2. Compt. rend. 1878, **87**, 500, abst. J. C. S. 1879, **36**, 36, Ber. 1879, **12**, 367; Jahr. Chem. 1878, **31**, 513. Dingl. Poly. 1889, **272**, 86, abst. J. S. C. I. 1889, **8**, 560. Chem. Centr. 1878, **49**, 721; Bull. Soc. Chim. 1880, **23**, 178. Biochem. Zts. 1908, **10**, 490

3. Ber. 1877, **10**, 81, Ann. 1878, **190**, 365; **191**, 125, abst. Jahr. Chem. 1877, **30**, 963, 364.

4. Ber. 1879, **12**, 1726; abst. Chem. Centr. 1879, **50**, 654

5. Chem. Centr. 1879, **50**, 766, Jahr. Chem. 1879, **32**, 1137

6. Ber. 1879, **12**, 1431, abst. J. C. S. 1880, **38**, 234; Chem. Centr. 1879, **50**, 614, Jahr. Chem. 1879, **32**, 411, Wag. Jahr. 1879, **25**, 917, Dingl. Poly. 1879, **234**, 77

7. Ber. 1870, **3**, 756, abst. Jahr. Chem. 1870, **23**, 486

8. E. P. 2322, 1880

9. Ber. 1880, **13**, 2439, abst. Wag. Jahr. 1881, **27**, 822, Jahr. Chem. 1880, **33**, 1206; Chem. Ztg. 1880, **4**, 840. Ber. 1882, **15**, 574, abst. Wag. Jahr. 1882, **28**, 903. Proc. Amer. Pharm. Assoc. 1882, **30**, 350. Pharm. Centralh. 1896, **38**, 353, Mondes, **53**, 439, Sucre, **16**, 517. Bull. Musee, **78**, 224. See also K. Foerster, Ber. 1882, **15**, 230. L. Marquardt, Ber. 1882, **15**, 1370, 1661.

10. S. Roessler, E. P. 3352, 1880

11. Dingl. Poly. 1880, **236**, 502, Jahr. Chem. 1880, **33**, 1351, Zts. Rubenzucker Ind. in der Oest. Ung. Monarchie 1877, 180, 1880, 20

12. E. P. 1750, 1876.

13. E. P. 726, 1875

14. Chem. Centr. 1881, **52**, 712, abst. J. C. S. 1882, **42**, 339; Jahr. Chem. 1881, **34**, 1202; Pharm. Centralh. 1880, **22**, 265, Brenn. Z., **11**, 29; Pharm. Centralh. 1885, **26**, 304; abst. Chem. Centr. 1885, **56**, 695; Jahr. Chem. 1885, **38**, 1974; Rep. anal. Chem. 1885, 252, Wag. Jahr. 1885, **31**, 885

15. Zts. Spiritusind. **4**, 458.

16. Ber. 1882, **15**, 230; abst. Jahr. Chem. 1882, **35**, 652; J. C. G. 1882, **42**, 1002; Chem. Centr. 1882, **53**, 234. Ber. 1882, **15**, 322, abst. Jahr. Chem. 1882, **35**, 1234; J. C. S. 1882, **42**, 710; Chem. Centr. 1882, **53**, 380. See also Ber. 1882, **15**, 574.

17. Wien. Acad. Ber. 1882, 183; Chem. Ztg. 1882, **6**, 961, abst. Bull. Soc. Ind. Rouen, **41**, 42.

Brockhaus,¹ C. Krauch,² J. Field,³ O. Reinke,⁴ G. Lunge and V. Meyer and E. Schulze,⁵ J. Uffelman,⁶ G. Bodländer and J. Traube,⁷ A. Bang and C. Ruffin,⁸ C. Bardy,⁹ T. Boswick,¹⁰ Broyer and Petit,¹¹ Colteloni,¹² G. and R. Clark,¹³ M. Deininger,¹⁴ E. Durin,¹⁵ F. Eckmann,¹⁶ H. Elsworthy,¹⁷ F. Fischer,¹⁸ H. Grote,¹⁹ Grote & Pinetta,²⁰ C. Girard and X. Rocques,²¹ L. Hugoncq,²² E. Holtz,²³ J. Hayduck,²⁴ C. Heinzelmann,²⁵ Herzfeld,²⁶ W. Hamlet,²⁷ R. Ilges,²⁸

1. Centr. öffentl. Gesundheitspf. 1882, 146, abst. Chem. Centr. 1882, **53**, 969; Wag. Jahr 1882, **28**, 905.
2. Rep. anal. Chem. **1**, 374; abst. Nahrungs. **4**, 184, Chem. Centr. 1882, **53**, 60, Zts. anal. Chem. 1883, **22**, 125; abst. Jahr. Chem. 1883, **36**, 1602.
3. D. R. P. 23153, abst. Wag. Jahr. 1883, **29**, 950.
4. Zts. Spiritusmd. **7**; Centr. Agrik. Chem. 1885, **14**, 214. Rep. anal. Chem. 1885, 150, abst. Jahr. Chem. 1885, **38**, 1973. Dmgl. Poly. 1887, **264**, 452, abst. Chem. Centr. 1887, **58**, 1126.
5. G. Lunge, V. Meyer and E. Schulze, Wag. Jahr. 1884, 1062, Chem. Centr. 1884, 854, Jahr. Chem. 1884, 1620. Organ. Rub. Z. **22**, 865, A. Landw. Gen. **4**, 178; Pharm. Centralb. 1883, **25**, 490.
6. Arch. f. Hygiene, **1**, 443, abst. Chem. Centr. 1884, **55**, 426, 741, Rep. anal. Chem. 1884, 187, Jahr. Chem. 1884, **37**, 427, 1657. Arch. J. Hygiene, **4**, 229, abst. Chem. Centr. 1886, **57**, 745.
7. Zts. Mineralwassermd. 1887, II, 167, Zts. Spiritusmd. 1887, 99; abst. Chem. Centr. 1887, **58**, 554, Chem. Tech. Rep. 1887, **26**, I, 70, Industrieb. 1887, 199.
8. D. R. P. 30902, 1884, abst. Wag. Jahr. 1887, **33**, 1056. D. R. P. 37355, 1886, addn. to D. R. P. 30902, 1884, abst. Wag. Jahr. 1886, **32**, 830, Ber. 1886, **19**, 392. D. R. P. 39785, addn. to D. R. P. 37355, 1886, abst. Chem. Centr. 1887, **58**, 1216, Wag. Jahr. 1887, **33**, 1056.
9. J. pharm. chim. 1888, (5), **18**, 274, 312, 369, 420, abst. Chem. Centr. 1888, **59**, 1428, 1599. Compt. rend. 1892, **114**, 1201, abst. Wag. Jahr. 1892, **38**, 937.
10. D. R. P. 43695, abst. Wag. Jahr. 1888, **34**, 1051.
11. J. pharm. chim. 1888, (5), **17**, 383, abst. Chem. Centr. 1888, **59**, 620.
12. Les Corps Gras Ind. **13**, 197, abst. Wag. Jahr. 1886, **32**, 830.
13. E. P. 5152, 1887, abst. J. S. C. I. 1888, **7**, 325.
14. D. R. P. 30843, 35510, abst. Wag. Jahr. 1886, **32**, 829.
15. Sucerie indigene et coloniale, **32**, 45; abst. Deut. Chem. Ztg. **3**, 251, Chem. Centr. 1888, **59**, 1186.
16. Chem. Ztg. 1888, **12**, 564. Zts. Landw. Gew. **9**, 122. Wag. Jahr. 1888, **34**, 1062.
17. Chem. News, 1887, **56**, 236, abst. J. C. S. 1888, **53**, 102; Jahr. Chem. 1888, **41**, 2609, Chem. Centr. 1888, **59**, 318.
18. Zts. Chem. Ind. 1887, **1**, 111, abst. Chem. Centr. 1887, **58**, 500.
19. E. P. 2109, 1887, abst. J. S. C. I. 1888, **7**, 129.
20. D. R. P. 41678, 1887, abst. J. S. C. I. 1888, **7**, 687; Wag. Jahr. 1887, **33**, 1057, Chem. Centr. 1888, **59**, 563.
21. Compt. rend. 1888, **107**, 1158, Bull. Soc. Chim. 1889, (3), **1**, 85; abst. Wag. Jahr. 1889, **35**, 1086; Chem. Centr. 1889, **60**, I, 168; Jahr. Chem. 1889, **42**, 2779.
22. Bull. Soc. Chim. 1886, **45**, 328, abst. Chem. Centr. 1886, **57**, 365; Jahr. Chem. 1886, **39**, 1302.
23. D. R. P. 39146, abst. Chem. Centr. 1887, **58**, 913; Jahr. Chem. 1887, **40**, 2634.
24. Zts. Spirits. Ind. Suppl. 1889, 51; abst. Wag. Jahr. 1889, **35**, 1078.

F. Japp and J. Raschen,¹ J. Laborde,² Ladislaus and Udransky,³ M. Lamb and D. Boyde,⁴ L. Lindet,⁵ C. Morin,⁶ J. Mayerhofer,⁷ Mierzinski,⁸ C. Ordonneau,⁹ F. Pampe,¹⁰ E. Pfeiffer,¹¹ Rose,¹² E. Roese,¹³ E. Sell,¹⁴ A. Stutzer and O. Reitmair,¹⁵ L. Schaertler,¹⁶ F.

See also Wag. Jahr 1888, **34**, 1052

25. Zts. Spiritusind. 1884, 1040, abst. Chem. Centr. 1888, **59**, 334; Zts. Spiritusind. 1912, **35**, 612; Deuts. Essigind. 1912, **16**, 434; Wag. Jahr. 1912, **58**, II, 425; Chem. Centr. 1913, **84**, I, 968; Zts. ang. Chem. 1913, **26**, 239; C. A. 1913, **7**, 676; J. S. C. I. 1912, **31**, 1142

26. Zts. Spiritusind. **102**, 661

27. Chem. News, 1888, **58**, 81, abst. Chem. Centr. 1888, **59**, 1318, 1320; Wag. Jahr. 1888, **34**, 1040, Jahr. Chem. 1888, **41**, 2816; Proc. Roy. Soc. N. South Wales, **21**, 111

28. D. R. P. 48343; abst. Chem. Tech. Rep. 1889, **28**, II, 65. E. P. 17927, 1892, abst. J. S. C. I. 1893, **8**, 283. D. R. P. 101323, abst. Chem. Centr. 1899, **70**, I, 1263. D. R. P. 103719, 103720, abst. Wag. Jahr. 1899, **45**, II, 881; Chem. Centr. 1899, **70**, II, 892. D. R. P. 105626, abst. Chem. Centr. 1900, **71**, I, 492.

1. J. C. S. 1886, **49**, 832, abst. Jahr. Chem. 1886, **77**, 1657. See also Jahr. Chem. 1885, **76**, 1649

2. Mon. Sci. 1888, (4), **2**, 1369, 1423, abst. Zts. Spirit. Ind. 1887, 376; Wag. Jahr. 1888, **34**, 1052; Chem. Centr. 1888, **59**, 18; Jahr. Chem. 1888, **41**, 2417

3. Zts. Physiol. Chem. 1888, **13**, 260, abst. Chem. Centr. 1889, **60**, I, 168

4. E. P. 10428, 1889, abst. J. S. C. I. 1890, **9**, 630.

5. Compt. rend. 1888, **107**, 182; abst. Chem. Centr. 1888, **59**, 1209; Bull. Soc. Chim. 1888, **2**, 164; J. C. S. 1888, **54**, 1263. Oestrr. Zts. Zuckerind. 1893, 875; abst. Wag. Jahr. 1893, **39**, 938. Compt. rend. 1891, **112**, 102, 663, abst. Chem. Centr. 1891, **62**, I, 545, 949; J. C. S. 1891, **60**, 813; Bull. Soc. Chim. 1891, 310; Wag. Jahr. 1891, **37**, 956; J. S. C. I. 1891, **10**, 7.

6. Compt. rend. 1887, **105**, 816, 1019, abst. Wag. Jahr. 1888, **34**, 977, 1066; Bull. Soc. Chim. 1887, **48**, 803; Chem. Centr. 1887, **58**, 1506; Jahr. Chem. 1887, **40**, 2652; J. S. C. I. 1888, **7**, 129. See also Zts. ang. Chem. 1889, **1**, 183; Compt. rend. 1888, **106**, 418

7. Ber. d. Bayer. Chem. 1887, 116, abst. Wag. Jahr. 1887, **33**, 1066; Chem. Centr. 1888, **59**, 873; Dingl. Poly. 1888, **268**, 126. See also Chem. Centr. 1886, **57**, 102, 1887, **58**, 1473. Poly. Notiz. 1888, **43**, 255.

8. Erfind. 1886, 289, 340

9. Compt. rend. 1885, **101**, 847, abst. Jahr. Chem. 1885, **38**, 1862; Compt. rend. 1886, **102**, 217; abst. Chem. Centr. 1886, **57**, 174; Jahr. Chem. 1886, **39**, 2135; Wag. Jahr. 1886, **32**, 833; Bull. Soc. Chim. 1886, **45**, 833; Organ. f. Zucker. Ind. Oest. Ungarn. N. F. **16**, 820, abst. Chem. Centr. 1888, **59**, 160.

10. Zts. Spiritusind. 1879, 38, 66, 137, 176, 221, abst. Chem. Tech. Rep. 1880, **19**, I, 110; Wag. Jahr. 1879, **25**, 917; Chem. Ztg. 1887, **11**, 313, 379; abst. Chem. Centr. 1887, **58**, 442. D. R. P. 205034, 1906; abst. C. A. 1909, **3**, 941; Jahr. Chem. 1909, **62**, II, 100. U. S. P. 1116322, 1914; abst. J. S. C. I. 1914, **33**, 1166; E. P. 8476, 1905, abst. J. S. C. I. 1906, **25**, 230.

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12. Rep. anal. Chem. **5**, 61. Zts. Spiritusind. **11**, 325; Zts. Landw. Gew. **8**, 154.

13. Pharm. Centralh. 1885, **27**, 5, abst. Ber. 1886, **19**, 184; Jahr. Chem. 1886, **39**, 1959; Chem. Centr. 1886, **57**, 102.

14. Arbeiten aus dem kaiserl. Gesundheits. Amt. **6**, 124, 335; **7**, 210;

Strassmann,¹ A. Smith,² J. Traube,³ J. Traube and G. Bodländer,⁴ K. Windisch,⁵ L. Udransky,⁶ L. Marquardt,⁷ C. Krauch,⁸ F. Rath,⁹ J. Stevens,¹⁰ H. Ujhely and J. Field,¹¹ and E. Sell and C. Windisch.¹²

From 1891 to 1900 may be said to comprize the developmental period in modern pyroxylin lacquers, and this naturally gave a corresponding impetus to nitrocellulose solvents, for it appears to be a well defined fact that the technology of cellulose esters only made permanent advancements at those periods when some one discovered new solvents, or improved methods of applying those already known. The work during this decade is illustrated by reference to the publications of Fabriques de Produits

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15 Rep anal Chem 1886, 335, 385, abst Chem Centr 1886, **57**, 603, 844, 951, Jahr Chem. 1886, **39**, 1969, Dingl Poly 1886, **261**, 442, Centr Gesundheitspfl 1886 (Suppl.), Wag Jahr 1886, **32**, 837, Zts Spiritusind, **46**, 370 See also Jahr Chem 1884, **37**, 1621, Chem Tech Rep 1890, **29**, II, 181, 278

16 Bohemian Pharm Zts Prag **7**, 386, abst Chem Centr 1889, **60**, II, 1005

17 Eulenburg's Vierteljahrschr **49**, No 2, abst Wag Jahr 1888, **34**, 1053, Berbr **20**, 379, Dent Vierteljahrschrift f Oeffentl Gesundheitspflege **22**, 418, Chem Centr 1890, **61**, I, 490

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3 Ber 1874, **7**, 892, 1884, **17**, 2294, abst Jahr Chem 1881, **37**, 55 Ber 1885, **18**, 882, 1886, **19**, 881, 883 Rep anal Chem **6**, 659, 661, abst Chem Centr 1886, **57**, 954 Cbl Agrik Chem **8**, 659, Rep anal Chem **36**, 301, Organ Rub 531, Chem News, 1887, **55**, 302 Ber 1887, **20**, 2690, 2842, abst Chem Centr 1887, **58**, 1473, 1592 Chem Ztg 1890, **14**, 1410, abst Chem Centr 1890, **61**, II, 859, 1410 E P 17972, 1888, abst J. S C I 1889, **8**, 995 Zts anal Chem 1889, **28**, 26, abst Chem Centr 1889, **60**, I, 236 Mon. Sci 1886, **28**, 1333

4 E. P 8387, 1887 D R P 41207, 1887, abst Zts Spirit Ind **12**, 230; Chem Centr. 1889, **60**, II, 829, Chem Tech Rep 1887, **26**, II, 99, Zts Presseheft, **9**, 287

5 Arb Kais Gesundheitsamt **5**, 373, **6**, 471, **8**, 110, **11**, 285, **14**, 309, abst Zts Spiritusind, **12**, 143, 1904, **27**, 311, Chem Centr 1889, **60**, II, 207, 1890, **61**, II, 614; 1895, **66**, I, 859, 900, Wag Jahr 1889, **35**, 1083, 1890, **36**, 1073, J S C I 1904, **23**, 876 Bull Soc Ind Rouen, 1913, **41**, 42

6 Zts Phys Chem **12**, 355, **13**, 248, abst Wag Jahr 1880, **26**, 1087, Amer Drug 1889, 70, Zts Spiritusind **12**, 57, J S C I 1889, **8**, 309

7 Ber 1882, **15**, 1370, 1661; abst Jahr Chem 1882, **35**, 1309

8 Zts anal Chem 1883, **22**, 125, abst Jahr Chem 1883, **36**, 1602

9 D R P 34117, abst Wag Jahr 1886, **32**, 829

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11 E P. 2512, 1882

12 Arb Kais. Gesundheitsamt **4**, 109, abst Zts Spiritusind 1888, 317 325; Chem. Ind. 1888 **11**, 528 Chem Tech. Rep 1888, **27**, II, 281.

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 • M. Defouge,⁵ G. Link and R. Avenarius,⁶ J. Long and C. Line-
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⁶ E. P. 48, 115, 1891, abst. J. S. C. I. 1891, **10**, 571.

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¹⁶ Chem. Ztg. 1890, **14**, 66, abst. Chem. Centr. 1890, **61**, I, 499.

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O. Saare and H. Hanow,¹ C. Weitenkamp,² F. Valentiner,³ Gretsche & Meyer,⁴ E. Beckmann and H. Brüggemann,⁵ W. Bigelow,⁶ A. Blaile,⁷ W. Bancroft,⁸ A. Bauer,⁹ E. Bamberger and A. Einhorn,¹⁰ E. deCuyper,¹¹ M. Dinesman,¹² N. Gerber and M. Craandijk,¹³ A. Jaroschenko,¹⁴ B. Jurgens,¹⁵ M. Kutscherow,¹⁶ K. Kruis and R. Rayman,¹⁷ M. Louguine,¹⁸ A. Monari and M. Carlinfanti,¹⁹ Picaud,²⁰ L. Polenske,²¹ Popper,²² X. Rocques,²³ C. Schmidt,²⁴ A. Stutzer and R. Maul²⁵ and L. Wolpian.²⁶

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9. U. S. P. 560771, 1896, E. P. 17703, 17781, 1893, abst. J. S. C. I. 1894, **13**, 903.

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12. E. P. 22139, 1896, abst. J. S. C. I. 1897, **16**, 258.

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19. Rivista d'igiene e Sanita Publica **6**, Sep., abst. Chem. Centr. 1895, **66**, II, 420.

20. Picaud, Compt. rend. 1897, **124**, 829.

21. Arb. Kaiserl. Gesundheits. Amt. **11**, 505, **13**, 301; abst. Chem. Centr. 1895, **66**, II, 548, Wag. Jahr. 1897, **43**, 989.

22. Zts. Spiritusind. **19**, 201; abst. Chem. Tech. Rep. 1896, **35**, 596.

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on this general subject have appeared from the following workers, and are fairly representative of the trend of development: T. Aldrich,¹ F. Adam,² L. Bouveault and G. Blanc,³ A. Bau,⁴ E. Beckmann,⁵ C. Daeschner,⁶ J. Effront,⁷ R. De Forcrand,⁸ L. Henry,⁹ C. Holley,¹⁰ A. Klages and R. Sautter,¹¹ A. Komarowsky,¹²

1. U. S. P. 761188, 761189, 1904; abst. Mon. Sci. 1904, **61**, 137, Chem. Zts. 1904, **3**, 692; Chem. Ztg. 1904, **28**, 602; J. A. C. S. 1905, **27R**, 57.
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W. Marckwald,¹ H. Mastbaum,² C. Nagel,³ E. Ritsert,⁴ T. Rudukoff and A. Alexandroff,⁵ M. Siegfeld,⁶ W. Affelhof,⁷ A. Bonis,⁸ S. Ball,⁹ C. Bedford,¹⁰ R. Bradbury,¹¹ M. Bouis,¹² E. Buchner and J. Meisenheimer,¹³ W. Brasch and E. Friedmann,¹⁴ W. Brasch,¹⁵ J. Carracido,¹⁶ W. Dudley,¹⁷ A. Fausten and Bengs,¹⁸ G. Garbarini,¹⁹ J. Graftiau,²⁰ A. Koch,²¹ H. Kreis,²² J. Lloyd,²³ E. Mann and C.

Chem 1903, **56**, 755; Wag. Jahr. 1903, **49**, II, 403; Chem. Centr. 1903, **74**, II, 742; Chem. Zts 1903, **27**, 1086; abst J. S. C. I. 1903, **22**, 1259; Jahr. Chem 1903, **56**, 755; Chem. Centr. 1903, **74**, II, 1396

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3. Zts. Spiritusind 1903, 533; abst. Wag. Jahr 1903, **49**, II, 402.

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¹Stacy, ¹F. Bayer & Co., ²R. Peters, ³H. Pringsheim, ⁴T. Richards and J. Mathews, ⁵P. Rinckleben, ⁶A. Schneider, ⁷A. Sultan and J. Stern, ⁸S. Sadtler, ⁹F. Sauer, ¹⁰T. Takahashi, ¹¹J. Tingle, ¹²T. Takeuchi and R. Inoue, ¹³V. Veley, ¹⁴O. Pampe, ¹⁵P. Schidrowitz and F. Kaye¹⁶ and P. Schidrowitz.¹⁷

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2. D. R. P. 151545; abst. J. C. S. 1904, **86**, i, 794. D. R. P. 173610, 173631; abst. J. C. S. 1906, **90**, i, 936. D. R. P. 254438, abst. J. S. C. I. 1913, **32**, 213. D. R. P. 256750, 1911; addn. to D. R. P. 254438; abst. J. S. C. I. 1913, **32**, 507. E. P. 4321, 1909; abst. J. S. C. I. 1909, **28**, 1223.
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5. *Zts. physik. Chem.* 1908, **61**, 449; abst. *Chem. Zentr.* 1908, **79**, I, 1020.
6. P. Rinckleben, *Chem. Ztg.* 1909, **33**, 777, 786; abst. C. A. 1910, **4**, 77.
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8. F. P. 305619, 1906; abst. J. S. C. I. 1906, **25**, 1000; C. A. 1907, **1**, 761, 2429. *Bull. Assoc. Chim. et dist.* **24**, 764; abst. *Chem. Zentr.* 1907, **78**, I, 771; *Jahr. Chem.* 1905-1908, II, 194.
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More recently the applications of fusel oil and its derivatives, and the subject of economical synthetic fusel oil formation, have been reported upon by C. Alsberg,¹ F. zu Aichlbürg,² M. Boswell and J. Gooderham,³ H. Bassett,⁴ Chem. Fabr. auf Actien vorm. E. Schering,⁵ A. Davis,⁶ E. Dunke,⁷ M. Dörfler,⁸ W. Dörflinger,⁹ R. Foerster,¹⁰ A. Fernbach,¹¹ A. Fernbach and E. Strange,¹² T. Fellenberg,¹³ O. Graul,¹⁴ A. Harden,¹⁵ W. Herz and A. Kurzer,¹⁶ E. Herzog,¹⁷ Badische Anilin & Sodafabrik,¹⁸ J. Kurono,¹⁹ G.

1905-1908, II, 195. Chem. Zentr. 1907, **78**, II, 270. See also J. S. C. I. 1910, **29**, 561. Cf. Lasches Mag. Sept. 1906, Analyst, 1905, **30**, 190, abst. Chem. Zentr. 1905, **76**, II, 276.

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2. E. P. 4904, 1910; abst. J. S. C. I. 1910, **29**, 99.
3. J. Ind. Eng. Chem. 1912, **4**, 667, abst. J. S. C. I. 1912, **31**, 946; Zts. ang. Chem. 1913, **26**, II, 539, Chem. Zentr. 1913, **84**, 859, C. A. 1913, **7**, 1783.
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5. E. P. 6497, 1912, abst. J. S. C. I. 1912, **31**, 900.
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7. Zts. Spiritusind. 1910, **33**, 150, abst. J. S. C. I. 1910, **29**, 585.
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10. Zts. Spiritusind. 1910, **33**, 537, abst. Chem. Zentr. 1910, **81**, II, 1830; see also Biochem. Zentr. 1910, **9**, 789, Chem. Zentr. 1910, **81**, I, 753.
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15. Chem. World, 1912, I, 12.
16. Zts. Electrochem. 1910, **16**, 241, 869, abst. Chem. Zentr. 1910, **81**, I, 1478, II, 1646.
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18. E. P. 18356, 1911, abst. J. S. C. I. 1912, **31**, 1008; C. A. 1913, **7**, 425. F. P. 435312, 1911; abst. J. S. C. I. 1912, **31**, 409, Mon. Sci. 1913, **79**, 132; Chem. Ztg. Rep. 1912, **36**, 306. E. P. 5125, 1912, abst. J. Soc. Dyers Col. 1912, **28**, 307; Chem. Ztg. Rep. 1912, **36**, 560, Friedlander, 1912-1914, **11**, 802; J. S. C. I. 1912, **31**, 795; C. A. 1913, **7**, 2854. D. R. P. 263716; abst. Wag. Jahr. 1913, **59**, II, 9, Chem. Ztg. Rep. 1913, **37**, 539; Zts. ang. Chem. 1913, **26**, 582; Friedlander, 1912-1914, **11**, 802; C. A. 1914, **8**, 211; Chem. Zentr. 1913, **84**, II, 1177. E. P. 18653, 1912, abst. J. S. C. I. 1913, **32**, 842; Friedlander, 1912-1914, **11**, 811; C. A. 1914, **8**, 553. F. P. 450461; abst. Mon. Sci. 1914, **81**, 6; C. A. 1913, **7**, 3197; Chem. Ztg. Rep. 1913, **37**, 320.

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6. *Zts. physiol. Chem.* 1911, **70**, 326, abst. J. S. C. I. 1911, **30**, 231; C. A. 1911, **5**, 1789.

7. *Oesterr. Chem. Ztg.* **16**, 309, abst. C. A. 1914, **8**, 2447.

8. E. P. 17235, 1912, abst. C. A. 1914, **8**, 433; *Chem. Ztg. Rep.* 1913, **37**, 644; J. S. C. I. 1913, **32**, 884; E. P. 15019, 1913, abst. J. S. C. I. 1914, **33**, 806.

9. E. P. 6903, 1912, abst. J. S. C. I. 1912, **33**, 547; E. P. 29088, 1913, abst. C. A. 1914, **8**, 2604.

10. E. P. 9722, 1911, abst. J. S. C. I. 1912, **31**, 547.

11. *Chem. Ztg.* 1912, **36**, 1438, abst. J. S. C. I. 1913, **32**, 103; C. A. 1913, **7**, 1577.

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13. U. S. P. 1074814, 1913, abst. C. A. 1913, **7**, 4041; *Mon. Sci.* 1914, **81**, 69.

14. U. S. P. 1100260, 1914, Re. 13829, 1914, abst. C. A. 1914, **8**, 2779; *Mon. Sci.* 1914, **81**, 140.

15. E. P. 17898, 1910, abst. J. S. C. I. 1911, **30**, 678.

16. F. P. 415160, 1910, abst. J. S. C. I. 1910, **29**, 1267.

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19. E. P. 17483, 1913, addn. to E. P. 14677, 1913, abst. J. S. C. I. 1914, **33**, 102, 219.

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Essex and I. Humphrey,¹ O. Matter,² H. Oeser,³ L. Katz,⁴ B. Brooks and H. Essex,⁵ F. Axtell,⁶ and W. Seifert.⁷

Amyl Acetate, of which eight esters are possible and all known, was first prepared in 1840 by A. Cahours,⁸ and subsequently investigated by H. Kopp,⁹ C. Friedel and J. Crafts,¹⁰ A. Hofmann,¹¹ A. Lieben and A. Rossi,¹² R. Gartenmeister,¹³ A. Lieben and S. Zeisel,¹⁴ A. Wurtz,¹⁵ C. Schorlemmer,¹⁶ G. Wagner and A. Saytzeff,¹⁷ N. Menschutkin,¹⁸ F. Flavitsky¹⁹ and others,²⁰

338; C. A. 1911, **5**, 2296.

21. J. A. C. S. 1916, **38**, 1368; abst. J. S. C. I. 1916, **35**, 906. See also J. S. C. I. 1915, **34**, 170. U. S. P. 1214919, 1915; abst. J. S. C. I. 1917, **36**, 403; C. A. 1917, **11**, 1019. See also H. Hibbert, U. S. P. 1008333, 1911.

1. U. S. P. 1233333, 1917; abst. J. S. C. I. 1917, **36**, 1029.

2. U. S. P. 1237076, 1917; abst. J. S. C. I. 1917, **36**, 1065.

3. D. R. P. 291978, 1915; abst. J. S. C. I. 1916, **35**, 833; addn. to D. R. P. 285978; abst. J. S. C. I. 1915, **34**, 1139.

4. J. Assoc. Off. Agr. Chem. 1917, **11**, 188; abst. C. A. 1917, **11**, 1011.

5. U. S. P. 1221667, 1917; abst. J. S. C. I. 1917, **36**, 569.

6. U. S. P. 1204638, 1916; abst. J. S. C. I. 1916, **35**, 1254.

7. Mitth. Chem. Vers. Heferenz. Lab. Wein u. Obstbau, Klosterneuburg, 1906; reprinted, Chem. Zentr. 1907, **78**, **II**, 346; abst. J. S. C. I. 1907, **26**, 63.

8. Ann. Chim. Phys. 1840, (2), **75**, 193; Ann. 1841, **37**, 167; J. prakt. Chem. 1841, **22**, 171; Berz. Jahr. 1842, **21**, 439; Chem. Centr. 1841, **12**, 245.

9. Ann. 1845, **55**, 187. See also Ann. 1848, **68**, 177.

10. Bull. Soc. Chim. 1864, **3**, 100; Ann. 1865, **133**, 207; Zts. Chem. 1864, **7**, 560; Jahr. Chem. 1864, **17**, 460; Chem. Centr. 1864, **35**, 314.

11. Ann. Chim. Phys. 1848, (3), **23**, 374; abst. Berz. Jahr. 1850, **29**, 485; Ann. 1852, **81**, 89; abst. J. prakt. Chem. 1852, **55**, 189; Dingl. Poly. 1852, **223**, 150; Ann. Chim. Phys. 1852, (3), **34**, 325; Pharm. J. in Trans. **11**, 420; Chem. Centr. 1852, **23**, 368.

12. Ann. 1871, **158**, 159; abst. Chem. Centr. 1871, **42**, 498; J. C. S. 1871, **24**, 1033.

13. Ann. 1886, **233**, 258; abst. Chem. Centr. 1886, **57**, 966; Jahr. Chem. 1886, **39**, 72; J. C. S. 1886, **50**, 960.

14. Monatsh. 1886, **7**, 53; abst. Bull. Soc. Chim. 1886, **46**, 669; J. C. S. 1886, **50**, 783; Chem. Centr. 1886, **57**, 468; Jahr. Chem. 1886, **39**, 1631. Also called methylethylcarbinol acetate.

15. Ann. 1864, **129**, 367; abst. Chem. Centr. 1864, **35**, 232; Compt. rend. 1863, **57**, 479. Ann. 1868, **148**, 132; abst. Chem. Centr. 1868, **39**, 869; Compt. rend. 1868, **66**, 1179.

16. J. prakt. Chem. 1866, **98**, 242; abst. Jahr. Chem. 1866, **19**, 527; Proc. Roy. Soc. 1867, **15**, 131; Chem. Centr. 1866, **37**, 719.

17. Ann. 1875, **175**, 366; abst. J. C. S. 1875, **28**, 627; Jahr. Chem. 1875, **30**, 277; Chem. Centr. 1874, **45**, 213; 1875, **46**, 149; Bull. Soc. Chim. 1875, **23**, 179.

18. Ann. Chim. Phys. 1881, (5), **20**, 289; abst. J. C. S. 1881, **40**, 36. Ber. 1882, **14**, 2630; abst. J. C. S. 1882, **42**, 383. Ber. 1882, **15**, 2512; abst. J. C. S. 1883, **44**, 309; Jahr. Chem. 1883, **36**, 190; Bull. Soc. Chim. 1883, **39**, 510. Compt. rend. 1882, **95**, 648; abst. Ber. 1882, **15**, 2512; J. C. S. 1883, **44**, 178; Jahr. Chem. 1882, **35**, 797; Bull. Soc. Chim. 1883, **39**, 328, 510; Chem. Centr. 1882, **53**, 758. Ann. Chim. Phys. 1884, (5), **30**, 81; abst. J. C. S. 1884, **46**, 726. See also N. Menschutkin and D. Konowloff, Ber.

the solvent properties for cellulose esters being first disclosed by J. Stevens in 1882.¹ Since that time the amyl acetates, especially the isoamyl esters have probably been the most important of the high-boiling direct cellulose nitrate solvents.

Amyl acetate is usually prepared by the original method of W. Wilson² consisting in the interaction of calcium acetate with fusel oil in the presence of a dehydrating agent (sulfuric acid). The C. Darzens method for esterification of alcohols by halogen-hydrogen acids;³ of H. Fournier by reacting upon organomagnesium compounds with acetic anhydride;⁴ the catalytic preparation of fatty acid esters in the wet way;⁵ and the processes of C. Tischenko and H. Plauson;⁶ L. Paget,⁷ D. McIntosh,⁸ and

1884, **17**, 1361, abst J C S 1884, **46**, 1119 D Konowaloff, Zts physik Chem. 1887, **1**, 63, abst J C S 1888, **54**, 340, 1053, Chem Centr 1887, **58**, 405; 1888, **59**, 270; Jahr Chem 1887, **40**, 1264, 1888, **41**, 28 For the dissociation of teramyl acetate in the presence of rough substances see V Meyer and G. Pond, Ber 1885, **18**, 1623, abst J C S 1885, **48**, 1033, Jahr Chem. 1885, **38**, 223, Bull. Soc Chim 1886, **14**, 896

19. Ann. 1875, **179**, 348; abst Chem Centr 1876, **47**, 309, J C S. 1876, **29**, 545. Also called dimethylethylcarbinol acetate

20. M. Berthelot, Compt rend 1876, **83**, 414 L Boltzmann, Pogg. Ann. 1879, **157**, 457. R. Bunsen and H. Roscoe, Pogg. Ann 1857, **100**, 81. P. Champion and H. Pellet, Compt rend. 1883, **77**, 55 R Clausius, Pogg. Ann 1857, **101**, 338. P. Favre and Silbermann, Ann Chim Phys 1852, (3), **34**, 441. R. de Forcrand, Compt rend 1883, **77**, 55 C Guldberg and P. Waage, J. prakt. Chem. 1879, **19**, 69. H. v. Helmholtz, Mathemat. u naturwissen. Mitt. Berl Akad 1884, 67 J. van't Hoff, Etudes de dynam chim Amsterdam 1884, 4. A Lieben and A. Rossi, Ann 1871, **159**, 70 L. Lilienfeld, Aust. P. 47237, 1910 W. Louguinine, Compt rend 1880, **90**, 1279, **91**, 298; 1881, **92**, 455, 526. I. Meyer, Die Moder Theoriend. Chem. 5 Aufl. 1884, 401, 405, 409. I. Mayer, Wien, Jahrsb Ober- Realschule, Inn. Stadt, 1863, **5**, 13. L. Pfaundler, Pogg. Ann 1867, **131**, 55, 79. E. Pringsheim, Zts. physik. Chem 1889, **3**, 154. C. v Rechenberg, J. prakt. Chem 1880, (2), **22**, 15, 21. E Sarrau and P. Vieille, Compt rend. 1881, **93**, 269. A. Schleiermacher, Wied. Ann. 1889, **36**, 346. J. Stefan, Sitzungsber. d Wien Akad. 1875, (2), 74. G. Stokes, Pogg. Ann. 1854, **136**, 619. J. Thomsen, Pogg. Ann. 1854, **92**, 34 A Williamson, Ann. 1851, **77**, 37; abst. J. C. S 1851, **4**, 106, 229. See also D d'Halluin, E. P. 2515, 1876.

1. U. S. P. 269342, 1882.

2. E. P. 4669, 1885, abst. J. S. C. I. 1886, **5**, 249; Ber 1886, **19**, 288. See also J. S. C. I. 1919, **38**, 1422, for manufacture in Canada.

3. Compt. rend. 1911, **152**, 1316; abst. Chem. Zentr. 1911, **82**, II, 74

4. Bull. Soc. Chim. 1910, **7**, 838; abst. Chem. Zentr. 1910, **81**, II, 1449. See also G. Stadinov, J. Russ. Phys. Chem. Soc. 1916, **48**, 297; abst. C. A. **10**17, **11**, 582.

5. J. Senderens and J. Aboulenc, Compt. rend. 1911, **152**, 1673, abst. Chem. Zentr. 1911, **82**, II, 440. In this connection refer to Dr. Neumann & Co., Chem. Fabrik G. m. b. H., and J. Zeltner, F. P. 466804, 1913; D. R. P. Ann. N-13832, 1912; abst. J. S. C. I. 1914, **33**, 845

6. E. P. 27428, 1912; abst. J. S. C. I. 1914, **33**, 244; C. A. 1914, **8**, 1851.

7. U. S. P. 494790, 494791, 494792, 494793, 1893; E. P. 7784, 7277,

the combination of anhydrides and alcohols in the presence of anhydrous calcium chloride,¹ have not been satisfactory commercial methods. The steadily increasing cost of amyl acetate in recent years has caused much research along lines of ester synthesis, the processes of H. Walker,² F. Kaufler,³ W. Maisland,⁴ Farbwerke Meister, Lucius & Bruening,⁵ Neumann & Co. G. m. b. H.,⁶ and H. Essex with I. Humphrey,⁷ and B. Brooks⁸ being representative of the general series of reactions whereby petroleum hydrocarbons are halogenized, and subsequently acetylated in the presence of various catalysts. The appearance of large quantities of normal butyl alcohol as a by-product in the fermentative preparation of acetone by the Weizmann and other similar methods undoubtedly will profoundly effect the synthetic preparations of amyl esters such as the acetate.

- Amyl acetate has been found in the oil of Eucalyptus globulus⁹ and in bananas.¹⁰ It is a colorless,¹¹ optically active,¹² refrac-

1893; abst. Proc. Amer. Pharm. Assoc. 1894, **43**, 740. See also E. ToId, U. S. P. 384005, 428654, 450264, 483701.

8 • J. A. C. S. 1917, **39**, 1073; abst. C. A. 1917, **11**, 1958.

1. Administration of the Mines of Buchsweiler, D. R. P. 232818, 1909; abst. Wag. Jahr 1911, **57**, II, 21, Zts. ang. Chem. 1911, **24**, 861, Chem. Zentr. 1911, **82**, I, 1000.

2. U. S. P. 972952, 1910; abst. J. S. C. I. 1910, **29**, 1322, F. P. 421058, 1910. U. S. P. 972953, 1910; abst. J. S. C. I. 1910, **29**, 1299. In this connection see also A. Maible, Chem. Ztg. 1911, **35**, 485, 1913, **37**, 777, 806; abst. Wag. Jahr 1911, **57**, II, 10, J. C. S. 1913, **104**, i, 1299.

• 3. U. S. P. 1106047, 1914; abst. C. A. 1914, **8**, 3219, J. S. C. I. 1914, **33**, 890; E. P. 2779, 1913; abst. J. S. C. I. 1913, **32**, 767, C. A. 1914, **8**, 2603; E. P. 3133, 1913; Addn. to E. P. 2779, 1913; abst. J. S. C. I. 1913, **32**, 1029, C. A. 1914, **8**, 789, F. P. 454275, 1913; abst. C. A. 1914, **8**, 211. D. R. P. Anni. K. 53797, 1913; abst. Kunst. 1913, **3**, 180.

4. U. S. P. 1077988, 1913; abst. C. A. 1914, **8**, 400. 1005013. U. S. P. 1102347, 1914; abst. C. A. 1914, **8**, 2123. See also E. I. du Pont Powder Co., E. P. 29962, 1912.

5. D. R. P. 282266, 1913; abst. C. A. 1915, **9**, 2426, Kunst. 1915, **5**, 36, 81; J. S. C. I. 1915, **34**, 686; J. C. S. 1915, **108**, i, 769.

6. F. P. 466804, 1913; abst. Mon. Sci. 1916, **83**, 14, Chem. Ztg. Rep. 1914, **38**, 581, C. A. 1915, **9**, 1370.

7. U. S. P. 1233333, 1917; abst. C. A. 1917, **11**, 2580.

8. U. S. P. 1197019, 1916; abst. C. A. 1916, **10**, 2965.

9. G. Bouchardat and Oliviero, Bull. Soc. Chim. 1893, **9**, 429, Schimmel's Report, 1904, I, 53.

10. C. Klover, Amer. Perfumer, **7**, 235; abst. C. A. 1913, **7**, 463. F. Rothenbach and L. Eberlein, Deut. Essigindustrie **9**, 81; abst. Chem. Centr. 1905, **76**, I, 1105; Jahr. Chem. 1905-08, II, 356.

11. W. Spring, Rec. trav. Chim. 1897, **16**, I; abst. Zts. physik. Chem. 1898, **27**, 176.

12. A. Colson, Compt. rend. 1894, **119**, 65; abst. Zts. physik. Chem. 1895, **16**, 753.

tive¹ liquid, readily decomposed by heat,² and miscible with amyl alcohol,³ and alcohol.⁴ Isoamyl acetate boils at 139.5°–140° at 726 mm.;⁵ dissolves CO₂⁶ and N,⁷ and resins;⁸ boils at 138.5–139° at 758.6 mm.⁹ and according to A. de Hemptinne,¹⁰ Bancroft,¹¹ J. Traube,¹² and the author,¹³ is difficultly soluble in water.

1. W. Delffs, *Neues Jahr. prakt. Chem.* **1**, 1, abstr. *Chem. Centr.* 1854 **25**, 274.

2. F. Flavitsky, *Ann.* 1875, **179**, 348. D. Konowalow, *Ber.* 1887, **20**, 187. *Zts. physik. Chem.* 1887, **1**, 63, abstr. *Chem. Centr.* 1887, **58**, 405. *Zts. physik. Chem.* 1888, **2**, 6; abstr. *Chem. Centr.* 1888, **59**, 270. *Zts. physik. Chem.* 1888, **2**, 387. N. Menshutkin, *Compt. rend.* 1882, **95**, 648. *Ber.* 1882, **15**, 2512. *Chem. News*, 1882, **46**, 207.

3. B. Moore and H. Roof, *Proc. Roy. Soc.* 1906, **77**, II, 86, abstr. *Chem. Centr.* 1906, **77**, I, 381.

4. H. Pfeiffer, *Zts. physik. Chem.* 1892, **9**, 472, abstr. *Jahr. Chem.* 1892, **45**, 201.

5. J. Bolle and P. Guye, *J. chim. phys.* 1905, **3**, 39, abstr. *Chem. Centr.* 1905, **76**, I, 868, *J. C. S.* 1905, **88**, ii, 233. See also J. Morgan and F. Owen, *J. A. C. S.* 1911, **33**, 1720; abstr. *Chem. Zentr.* 1912, **93**, I, 541.

6. G. Just, *Zts. physik. Chem.* 1901, **37**, 354, abstr. *J. C. S.* 1901, **80**, ii, 439.

7. F. Dolezalek, *Zts. physik. Chem.* 1910, **71**, 191, abstr. *Chem. Zentr.* 1910, **81**, I, 982.

8. C. Coffignier, *Bull. Soc. Chim.* 1910, **7**, 1049, 1911, **9**, 549, abstr. *Chem. Zentr.* 1911, **82**, I, 289, 355.

9. R. Schiff, *Ann.* 1883, **220**, 110, abstr. *Jahr. Chem.* 1884, **37**, 101, *Chem. Centr.* 1884, **55**, 482, *Bull. Soc. Chim.* 1886, **46**, II, 829, *J. C. S.* 1885, **48**, 717; *Gaz. chim. ital.* 1884, **14**, 292, *Ber.* 1886, **19**, 560. The b. pt. is given as 138° by H. Kopp, *Ann.* 1855, **94**, 294, *Sill. Amer. J. Sci.* (2), **20**, 407, *Ann.* 1855, **95**, 121, 1855, **96**, 153, 303; *Compt. rend.* 1855, **41**, 186, *Jahr. Chem.* 1855, **8**, 18, *Chem. Centr.* 1855, **16**, 116, 769.

10. *Zts. physik. Chem.* 1894, **13**, 561, abstr. *Chem. Centr.* 1894, **65**, I, 1108; *J. C. S.* 1894, **66**, ii, 274, *Jahr. Chem.* 1894, **47**, 285. He found that a liter of water saturated at 25° contains in gms. the following esters: amyl acetate 1.622, amyl propionate 0.908, amyl butyrate 0.505, isobutyl acetate 6.322, propyl propionate 5.623, methyl butyrate 10.726, ethyl butyrate 6.862, ethyl valerate 2.366.

11. *Phys. Rev.* 1895–1896, **3**, 131, 196, 205. He found the solubility of amyl esters in water at 20° to be: amyl acetate 0.2%, isoamyl acetate 0.2%, amyl butyrate 0.06%, amyl propionate 0.1%, isoamylformate 0.3% (the latter at 22°). When 5 cc. ethyl alcohol in each instance was mixed with the cc. of water stated, the cc. isoamyl acetate dissolved is given: 7 cc. water, 0.41 cc. isoamyl acetate dissolved; 6 cc. — 0.7 cc., 5 cc. — 1.31, 3.61 — 3.0, 3.01 — 4.0, and 2.60 cc. water, 5.0 cc. isoamyl acetate dissolved.

12. *Ber.* 1884, **17**, 2304; see under ethyl acetate.

13. Unpublished communication, operating upon 100 cc. samples of amyl acetate b. pt. 138.6°–138.65° (corr.) and miscible with 20 volumes benzene without opalescence, gave a solubility in water at 17.5° of 0.28%–0.31% by volume, as the mean of six series of determinations. It will be remembered that commercial amyl acetate contains among other things, ethyl, propyl, butyl and amyl alcohols, ethyl propyl, and butyl acetates, amyl formate and a trace of water. The density will increase with the amount of water present, but this is seldom sufficient to cause an appreciable effect. The density will increase with increase of lower acetates for the specific gravity of the acetates decrease from methyl acetate to amyl acetate, and in isomeric acetates from the normal to the tertiary esters.

Compared with water it has a density of 0.8837 at 0°, 0.8762 at 15°,¹ 0.8745 at 17.9°,² 0.8561 at 20°,³ 0.870843 at 20°,⁴ 0.86208 at 25°,⁵ 0.8659 at 25°,⁶ and 0.7429 at 138.7°.⁷ The dielectric constant⁸ electrolytic conductivity,⁹ hydrolysis,¹⁰ absorption coefficient,¹¹ molecular rotation¹² and cohesion,¹³ surface tension,¹⁴ sapon-

1. D. Mendelejeff, *Compt. rend.* 1860, **50**, 52, abst. *Jahr. Chem.* 1860, **13**, 7; *Chem. Centr.* 1860, **31**, 177; *Chem. Zts* 1860, **3**, 49, *Rep. Chim. Pure*, 1860, **2**, 109.

2. F. Eisenlohr, *Zts. physik. Chem.* 1910, **75**, 585; abst. *J. C. S.* 1911, **100**, i, 81; *Chem. Zentr.* 1911, **1**, 1912; *C. A.* 1911, **5**, 1218.

3. H. Landolt, *Pogg. Ann.* 1864, **122**, 545, 1864, **123**, 595; abst. *Chem. Centr.* 1865, **36**, 112; *Jahr. Chem.* 1864, **17**, 101.

4. V. Polowzow, *Zts. physik. Chem.* 1910, **75**, 520; abst. *Chem. Zentr.* 1911, **82**, I, 609; *J. C. S.* 1911, **100**, ii, 101, *C. A.* 1911, **5**, 1012.

5. D. Tyrer, *J. C. S.* 1910, **97**, 2624; abst. *Chem. Zentr.* 1910, **81**, I, 1668; *Bull. Soc. Chim.* 1911, **10**, 1205, *Chem. Ztg.* 1910, **34**, 309, *J. S. C. I.* 1910, **29**, 1195; *C. A.* 1910, **4**, 1569, 3134.

6. F. Thole, *J. C. S.* 1910, **97**, 2601; abst. *Chem. Zentr.* 1911, **82**, I, 643; *Bull. Soc. Chim.* 1911, **10**, 1208; *Chem. News*, 1910, **102**, 328. For the optical rotation of amyl acetate see A. Colson, *Compt. rend.* 1894, **119**, 65; abst. *Jahr. Chem.* 1894, **47**, 168; 1895, **48**, 256, *J. C. S.* 1894, **66**, ii, 435; *Chem. Centr.* 1894, **105**, II, 353; *Chem. News*, 1894, **70**, 49.

7. R. Schiff, loc. cit. For sp. gr., b. pt., refractive index and ester percentage of the esters used in perfumery and for flavoring purposes, see *Pharm. Jour.* 1912, Special Issue, p. 11-13. For densities and specific volumes of mixtures of isoamyl acetate with dibromobenzene and with diphenyl, see D. Tyrer, loc. cit. For reaction of isoamyl acetate with methyl and ethyl alcohol, see T. Purdie and W. Marshall, *J. C. S.* 1888, **53**, 394; abst. *Jahr. Chem.* 1888, **51**, 1690; *Chem. Centr.* 1888, **59**, 660. Amyl monochloracetate (L. Hugouenq, *Bull. Soc. Chim.* 1886, **45**, 328; abst. *Jahr. Chem.* 1886, **39**, 1302; *Chem. Centr.* 1886, **57**, 365), and amyl trichloracetate (A. Clermont, *Compt. rend.* 1883, **96**, 437; abst. *J. C. S.* 1883, **44**, i, 729; *Jahr. Chem.* 1883, **36**, 1031; *Bull. Soc. Chim.* 1883, **40**, 302; *Chem. Centr.* 1883, **54**, 214) are both excellent solvents of the cellulose nitrates, but their proneness to become acid upon standing, precludes their use.

See also E. Beckmann and V. Gerhardt, *Zts. physik. Chem.* 1895, **18**, 490. J. Bolle and P. Guye, *J. Chim. Phys.* 1905, **3**, 38; abst. *Chem. Centr.* 1905, **76**, I, 868. A. Dunstan and P. Hilditch, *Zts. Electrochem.* 1912, **18**, 187. L. Kossakowsky, *Zts. physik. Chem.* 1894, **8**, 263. P. Walden, *Zts. physik. Chem.* 1894, **15**, 643.

8. D. Dobrosserdow, *J. Russ. Phys. Chem. Soc.* 1909, **41**, 1164, 1385; abst. *Chem. Centr.* 1910, **82**, I, 718, 790. P. Drude, *Zts. physik. Chem.* 1897, **23**, 308; abst. *Chem. Centr.* 1897, **68**, II, 247. S. Tereschin, *Zts. physik. Chem.* 1897, **23**, 308.

9. A. Ssachanov, *J. Russ. Phys. Chem. Soc.* 1911, **42**, 1363; abst. *Chem. Zentr.* 1911, **82**, I, 529.

10. O. Sulc, *Zts. Physik. Chem.* 1900, **33**, 47; abst. *Jahr. Chem.* 1900, **53**, 818.

11. A. McDaniel, *J. Phys. Chem.* **15**, 587; abst. *Chem. Zentr.* 1911, **82**, II, 668.

12. L. Tschugaeff, *Ber.* 1898, **31**, 360; abst. *J. C. S.* 1898, **74**, ii, 274, 495.

13. D. Mendelejeff, *Compt. rend.* 1860, **50**, 52; **51**, 97; abst. *Zts. Chem.* 1860, **3**, 49; *Chem. Centr.* 1860, **31**, 177; *Rep. Chim. Pure*, 1860, **2**, 109.

14. T. Renard and P. Guye, *J. chim. phys.* 1907, **5**, 81; abst. *Chem. Zentr.* 1907, **78**, I, 1478.

ification¹ velocity¹ and other physical constants² have been determined with great accuracy.

Endeavors to produce commercial amyl acetate substitutes as in the processes of L. Paget³ and E. Todd⁴ have not been satisfactory.

The uses of amyl acetate are many and varied. In addition to its application as a solvent for nitrocellulose,⁵ celluloid,⁶ elemi,⁷

1. L. Reicher, *Ann.* 1885, **228**, 257, 281; *abst. Zts. physik. Chem.* 1894, **15**, 398.

2. R. Abegg, *Zts. physik. Chem.* 1894, **15**, 233. H. Armstrong and E. Frankland, *Proc. Roy. Soc.* 1909, **82**, 588; *abst. Chem. Zentr.* 1910, **81**, II, 1231. B. van Dyken, *Rec. trav. Chim.* 1895, **14**, 106; *abst. Zts. physik. Chem.* 1895, **18**, 192; see also *J. prakt. Chem.* 1876, **121**, 561. F. Eisenlohr, *Zts. physik. Chem.* 1910, **75**, 592; *abst. Chem. Zentr.* 1911, **82**, I, 624. P. Favre and Silberman, *Ann. Chim. Phys.* 1852, (3), **34**, 441, *abst. Zts. physik. Chem.* 1890, **6**, 352. F. Guthrie, *N. Arch. ph. nat.* **35**; *Proc. Roy. Soc.* 1869, **17**, 234, *Phil. Mag.* 1869, (4), **37**, 468, *L'Institut.* 1869, 310; *Jahr. Chem.* 1869, **22**, 142. P. Guye, *Zts. physik. Chem.* 1894, **15**, 643. P. Guye and A. Je Armal, *Arch. sci. phys. nat.* 1895, **33**, 409, 513, *abst. Zts. physik. Chem.* 1896, **19**, 179. P. Guye and L. Chavanne, *Bull. Soc. Chim.* 1896, **15**, 177. S. Henriksen, *Wied. Ann.* 1888, **34**, 180; *abst. Zts. physik. Chem.* 1888, **2**, 548. E. Kaiser and L. McMaster, *J. A. C. S.* 1910, **32**, 390; *abst. Chem. Zentr.* 1910, **81**, I, 1420. H. Landolt and H. Jahn, *Zts. physik. Chem.* 1892, **10**, 320, *Jahr. Chem.* 1892, **45**, 473. K. Lehmann, *Arch. Hyg.* **27**, 260; *abst. C. A.* 1913, **7**, 2432. K. Meyer, *Ann.* 1911, **380**, 225; *abst. Chem. Zentr.* 1911, **82**, I, 1534. E. Mohler, *Compt. rend.* 1890, **111**, 187; *abst. Chem. Centr.* 1890, **61**, II, 567. L. Morel and E. Terronne, *Compt. rend.* 1909, **149**, 236; *abst. Chem. Zentr.* 1909, **80**, II, 1633. G. Oddo and E. Scandola, *Gaz. chim. ital.* 1910, **40**, 163; *abst. Chem. Zentr.* 1910, **81**, II, 1581. W. Perkins, *J. C. S.* 1894, **65**, 402; *abst. Zts. physik. Chem.* 1894, **15**, 503. See also *Zts. physik. Chem.* 1893, **12**, 433. V. Polowzow, *Zts. physik. Chem.* 1910, **75**, 522, *abst. Chem. Zentr.* 1911, **82**, I, 609. G. de Rossi and A. Sella, *Nuova Cimento*, (5), **4**, 94, *abst. Zts. physik. Chem.* 1903, **44**, 638. O. Sackur, *Zts. physik. Chem.* 1910, **70**, 487; *abst. Chem. Zentr.* 1910, **81**, II, 888. S. Sminov, *J. Russ. Phys. Chem. Soc.* 1911, **43**, 1; *abst. Chem. Zentr.* 1911, **82**, I, 1683. E. Terronne, *Biochem. Zts.* 1910, **23**, 451; *abst. Chem. Zentr.* 1910, I, 1155. V. Vermorel and E. Dantony, *Compt. rend.* 1910, **151**, 1144; *abst. Chem. Zentr.* 1911, I, 506. S. Young and C. Fortey, *J. C. S.* 1903, **83**, 45; *abst. Chem. Centr.* 1903, **74**, I, 431. See also *J. C. S.* 1867, **19**, 485. L. Brown, *J. C. S.* 1906, **89**, 311; *abst. Chem. Centr.* 1906, **77**, I, 1087.

3. E. P. 7277, 1893; *abst. J. S. C. I.* 1893, **12**, 620. He also esterifies a mixture of acetic and salicylic acids with methyl, ethyl and amyl alcohols, producing a mixture of methyl, ethyl, and amyl acetates and salicylates. The cost of such a mixture must be greater than amyl acetate if substantial amounts of salicylic acid is used without a corresponding increase in desirable properties. E. P. 7784, 1893; *abst. J. S. C. I.* 1893, **12**, 701. He claims the distillation of methyl, ethyl and amyl alcohol with benzine and an acetate or acetic acid results in a solvent which is superior to a mere mixture of methyl, ethyl and amyl acetates with the same benzine. This, however, is not so.

4. U. S. P. 384005, 1888; 428654, 1890; 450264, 1891; 483701, 1892.

5. M. Waterhouse, *Bull. Soc. Franc. Phot.* 1889, **5**, II, 116. W. Theodorovic, *E. P.* 949, 1896. Wilson and Storey, *E. P.* 491, 1885; *abst. J. S. C. I.* 1886, **5**, 35.

6. H. Trimble, *Amer. J. Pharm.* 1887, **59**, 275; *Schweiz. Wochenschrift f. Pharm.* **25**, 344; *Chem. Centr.* 1887, **58**, 1456; *Jahr. Chem.* 1898, **51**, 819;

copal,¹ cellulose ester plastics,² it has been extensively employed in lacquers,³ hardening skins,⁴ deodorizing petroleum,⁵ soaps⁶ and peat,⁷ as a constituent in color photography⁸ and in bronzing compositions.⁹ In polishing compositions,¹⁰ two-liquid dry batteries,¹¹ pharmaceuticals,¹² stearin solvent¹³ and other solvent uses,¹⁴

Bayer. Ind. Gewerbebl. 1887, **19**, 658, Pharm. J. Trans (3), **17**, 1054; abst. Jahr. Chem. 1887, **40**, 1592. U. S. P. 269340 (see Celluloid vs. Crane Chemical Co., Fed. Rep. 110). Amer. J. Pharm. 1887, **59**, 313. Cosmos, 1909, **61**, 306.

7. J. Matray, F. P. 477294, 1914; abst. J. S. C. I. 1917, **35**, 597.
1. Bull. Soc. Chim. 1902, (3), **27**, 549, abst. Chem. Centr. 1902, **73**, II, 433; J. S. C. I. 1902, **21**, 918. Bull. Soc. Chim. 1903, (3), **29**, 551; abst. Chem. Centr. 1903, **74**, II, 246; J. S. C. I. 1903, **22**, 808. Bull. Soc. Chim. 1905, (3), **33**, 169; abst. Chem. Centr. 1905, **76**, I, 606; J. S. C. I. 1905, **24**, 203. Bull. Soc. Chim. 1906, (3), **35**, 1143, abst. J. S. C. I. 1906, **25**, 1226. Bull. Soc. Chim. 1907, (4), **1**, 1131, abst. Jahr. Chem. 1905-08, II, 3122. Bull. Soc. Chim. 1909, (4), **5**, 289, abst. J. S. C. I. 1909, **28**, 430; Z. ang. Chem. 1909, **22**, 1854, Chem. Zentr. 1909, **80**, I, 1478; J. C. S. 1909, **96**, i, 317. C. A. 1907, **3**, 913; 1908, **2**, 902, 1895, 2022, 1909, **3**, 2062. For solubility determinations of copal and other resins in amyl acetate and other solvents see Vol. II.

2. W. Beatty, Aust. P. 63966, 1913. E. P. 18822, 1912, 18499, 1913. F. P. 447645, abst. C. A. 1913, **7**, 2115; 1914, **8**, 572, 1915, **9**, 377.

3. E. Brommert and T. Schlumberger, E. P. 6858, 1896. W. Clark and G. Ruxley, E. P. 8207, 1900. H. Goetter, U. S. P. 597144, 1898. S. Hobday, E. P. 10110, 1904. T. Hughes, E. P. 8513, 1889. Societe A. Patat et Cie, F. P. 361954. J. Stevens, U. S. P. 269340, 1882, 595355, 1897; 610728, 1898. See also R. Schupphaus, U. S. P. 514838. E. Flaherty, U. S. P. 1341710. H. Trimble, Pharm. J. Trans (3), **17**, 1054; abst. Jahr. Chem. 1887, **40**, 1592.

4. K. Hartmann, E. P. 16810, 1911; 29997, 1912; abst. J. S. C. I. 1912, **31**, 82; 1913, **32**, 618.

5. E. Charbonneaux, F. P. 354884, 1905. L. Stouvenaut, F. P. 326637, 1902.

6. A. Janousek, E. P. 23117, 1910; F. P. 422752, 1910, abst. J. S. C. I. 1911, **30**, 559, 755.

7. S. Heimann, U. S. P. 663572; abst. Centr. Akk. Tech. 1901, **2**, 36.

8. J. Bamberger, E. P. 15775, 1911. J. Christensen, E. P. 25419, 1913; 13260, 1914, abst. J. S. C. I. 1914, **33**, 1226; 1915, **34**, 199; J. S. C. I. Ann. Rep. 1916, **1**, 307.

9. J. Perl, E. P. 3557, 1893; abst. J. S. C. I. 1893, **12**, 307, 484, 530.

10. R. Brown, E. P. 18134, 1915; abst. C. A. 1917, **11**, 1894. C. Ellis, U. S. P. 999491, 1911. W. Roffey and M. Roffey, E. P. 27960, 1911.

11. C. Torley and O. Matter, F. P. 457843, 1913, abst. J. S. C. I. 1913, **32**, 1003; E. P. 9451, 1913; abst. J. S. C. I. 1914, **33**, 569. F. P. 337570, 1903; abst. Le Rev. elect. 1904, **2**, 46; Centr. Akk. Tech. 1904, **5**, 236.

12. Anon., Lab. Rep. Med. Assoc. 1915, **8**, 80; abst. C. A. 1916, **10**, 2961.

13. L. Barringer, U. S. P. 1009630, 1911; abst. J. S. C. I. 1911, **30**, 1459; E. P. 19035, 1905; abst. J. S. C. I. 1906, **25**, 700. U. S. P. 1091621, 1914; abst. C. A. 1914, **33**, 1877; Kunst. 1914, **4**, 256.

14. British Thomson-Houston Co., E. P. 13946, 1910. A. Cocking, E. P. 25081, 1905. G. Guittet, E. P. 6717, 1907; Addn. 7457, to F. P. 367989, 1907. G. Hoffmann, D. R. P. 316604, 1917; abst. J. S. C. I. 1920, **39**, 460-A. J. Hamilton, E. P. 9473, 1911. J. Hertkorn, E. P. 17220, 1908. C. Koettnitz, D. R. P. 191839; abst. Wag. Jahr. 1907, **53**, II, 522. G. Heyl

amyl acetate finds useful employment. The utilization of this ester in the processes of C. Ellis,¹ H. Dugour,² C. Guittet,³ R. Hense,⁴ E. Armstrong,⁵ E. Ohr,⁶ W. Stevens,⁷ S. Hermann,⁸ A. Rousseau,⁹ K. Hartmann¹⁰ and P. Ward¹¹ are typical examples of usefulness. In connection with the unflammable cellulose esters, amyl acetate has been proposed as a precipitant for cellulose formate¹² and acetate,¹³ cellulose esters both soluble¹⁴ and

and T. Baker, E. P. 10055, 1913. Vereinigte Glanzstoff Fabrik, Swiss. P. 53777; Belg. P. 231853, 1911, Can. P. 134164, 1911, abst. J. S. C. I. 1911, **30**, 484, 615, 741, 888, C. A. 1911, **5**, 3310, 1912, **6**, 3188, Kunst. 1912, **2**, 255, 393. J. Kessler, U. S. P. 708649, 1902, abst. J. S. C. I. 1902, **21**, 1213. T. Durran, J. Chem. Technology, abst. Chem. and Drug. 1916, **88**, 181, abst. C. A. 1916, **11**, 1076. F. Thole, J. C. S. 1910, **97**, 2596, abst. Chem. Zentr. 1911, **82**, I, 643. F. Sparre, U. S. P. 1266073, 1918. D. Tyrer, J. C. S. 1910, **97**, 2627, abst. Chem. Zentr. 1911, **82**, I, 609. A. G. Anilmfabr., F. P. 459922, 1913; E. P. 17523, 1913, abst. J. S. C. I. 1913, **32**, 1163. A. Clapp, U. S. P. 1280399, abst. C. A. 1918, **12**, 2687.

1. U. S. P. 817141, 1903, abst. J. S. C. I. 1906, **25**, 434, Mon. Sci. 1907, **67**, 57. U. S. P. 876304, 1908, abst. C. A. 1908, **2**, 1500.

2. E. P. 12556, 1907, abst. J. S. C. I. 1908, **27**, 683, C. A. 1909, **3**, 250. F. P. 392505, 1908, abst. Mon. Sci. 1910, **73**, 107, J. S. C. I. 1908, **27**, 1202.

3. F. P. 367989, 1906; abst. J. S. C. I. 1906, **25**, 1226, C. A. 1907, **1**, 1762. First Add. dated Mar. 18, 1907, to F. P. 367989, 1906, abst. J. S. C. I. 1907, **26**, 1020. E. P. 6717, 1907, abst. J. S. C. I. 1908, **27**, 30.

4. E. P. 14671, 1907, abst. J. S. C. I. 1908, **27**, 799, C. A. 1909, **3**, 1340.

5. E. Armstrong, U. S. P. 1041229, 1912, abst. C. A. 1912, **6**, 3499.

6. E. Ohr and O. Schlegel, F. P. 363592, 1906, abst. J. S. C. I. 1906, **25**, 897.

7. E. P. 4390, 1908, abst. J. S. C. I. 1909, **28**, 381, C. A. 1909, **3**, 2381. Soc. industrielle de Cellulose, D. R. P. 141310, 1902, abst. Chem. Centr. 1903, **74**, I, 1164, Jahr. Chem. 1903, **56**, 1020; Zts. ang. Chem. 1903, **16**, 425.

8. U. S. P. 1008332, 1912, abst. C. A. 1912, **6**, 301.

9. A. Rousseau, F. P. 383062, 1907, abst. J. S. C. I. 1908, **27**, 330. U. S. P. 909457, 1909, abst. J. S. C. I. 1909, **28**, 137, C. A. 1909, **3**, 1093.

10. D. R. P. 244566, 1910, abst. C. A. 1912, **6**, 2339. E. P. 16810, 1911, abst. J. S. C. I. 1912, **31**, 82, C. A. 1913, **7**, 289.

11. P. Ward and E. Gregory, E. P. 8481, 1890, abst. J. S. C. I. 1890, **9**, 893. It has been proposed by C. Du Motay and A. Rosst (E. P. 1284, 1880) to increase the safety in the transportation of liquids like amyl acetate by rendering them unflammable by saturation with sulfurous acid, the latter being subsequently expelled by gently heating the solution.

12. E. P. 309, 1911, abst. J. S. C. I. 1911, **30**, 484. E. P. 424621, 1911, abst. J. S. C. I. 1911, **30**, 741. E. P. 29246, 1910, abst. J. S. C. I. 1911, **30**, 888, C. A. 1911, **5**, 3340. F. P. 423774, 1910, abst. J. S. C. I. 1911, **30**, 615. D. R. P. 249535, 1910; C. A. 1912, **6**, 3183. Swiss. P. 53777, abst. Kunst. 1912, **2**, 255. Belg. P. 231853, 1911. Aust. P. 54512, 1912, abst. Kunst. 1912, **2**, 393. Can. P. 134164, 1911. For action of amyl formate on cellulose esters see U. S. P. 904269, 1908, abst. J. S. C. I. 1908, **27**, 1202. E. P. 4597, 1906, abst. J. S. C. I. 1907, **26**, 146. D. R. P. 175664, 1903, abst. Zts. ang. Chem. 1907, **20**, 461. U. S. P. 888516, abst. J. S. C. I. 1908, **27**, 683; C. A. 1908, **2**, 2866. E. P. 592, 1907; abst. J. S. C. I. 1908, **27**, 73, C. A. 1908, **2**, 2018. D. R. P. 169782, 1904. D. R. P. 182773, 1904; abst. Zts. ang. Chem. 1907, **20**, 2090. E. P. 14483, 1903; abst. J. S. C. I. 1903, **22**, 1345.

13. D. R. P. 210519, 1907; abst. J. S. C. I. 1909, **28**, 812, Zts. ang. Chem.

nsoluble¹ in amyl acetate having been described and patented.

As a standard in photometry, amyl acetate was first proposed in 1883 by F. von Hefner-Alteneck and was subsequently developed by himself,² H. Bunte,³ A. Bannow,⁴ E. Brodhun,⁵ H. Dreschmidt,⁶ D. Coglievina,⁷ J. Elster,⁸ Hasse,⁹ H. Krüss,¹⁰ L. 1909, **22**, 1020.

14. F. P. 375092, 1907; abst. J. S. C. I. 1907, **26**, 877.
1. U. S. P. 734123, 1903; abst. J. S. C. I. 1903, **22**, 961; Mon. Sci. 1903, **60**, 173. D. R. P. 153350, 1901; abst. Zts. ang. Chem. 1904, **17**, 1697; Chem. Centr. 1904, **75**, II, 625; Jahr. Chem. 1904, **57**, 1168; Chem. Ind. 1904, **27**, 538; J. C. S. 1904, **86**, i, 853. U. S. P. 790565, 1905; abst. J. S. C. I. 1905, **24**, 686. D. R. P. 159524, 1901; abst. Chem. Centr. 1905, **76**, II, 527; Zts. ang. Chem. 1905, **18**, 1636; Jahr. Chem. 1905-08, II, 984; J. C. S. 1906, **90**, i, 6. E. P. 21628, 1901; abst. J. S. C. I. 1902, **21**, 870. F. P. 317007, 1901; abst. J. S. C. I. 1902, **21**, 870; Mon. Sci. 1903, **60**, 54. Aust. P. 31391. It. P. 62042, 1901.
2. J. Gasbel. 1884, **27**, 766; abst. J. Gas Light. 1886, **47**, 1254. J. Gasbel. 1887, **30**, 489; 1903, **46**, 35, 348. Elektrotech. Zts. 1884, **5**, 20; abst. Brühl. Phys. 1884, **8**, 504; Chem. Centr. 1884, **55**, 661. He investigated the effect of impurities in the amyl acetate on the photometric power (J. Gasbel. 1891, **34**, 349; abst. J. Gas Light. 1892, **59**, 295; J. S. C. I. 1891, **10**, 909; Jahr. Chem. 1891, **44**, 2786) and gives results for admixture of diamylene 2%, alcohol 5%, castor oil 4%, isobutyl acetate 10%, amyl alcohol 10%, and alcohol 50%, with amyl acetate to make 100%, and found that small amounts of impurities do not affect the illuminating power of the amyl acetate to any great extent. For examination of amyl acetate for suitability as a photometric standard, see J. Gasbel. 1891, **34**, 266. For comparison of spermaceti candles with the Hefner light, see J. Gasbel. 1891, **34**, 432. See also J. S. C. I. 1891, **10**, 685. The illuminating power of other esters as compared with amyl acetate pure as 100 is given by Hefner as follows (J. Gas Light. 1887, **50**, 16)—amyl valerate 103, amyl formate 101, isobutyl acetate 99, isobutyl formate 97, ethyl acetate 24. It shows that quite differently constituted substances will burn with about the same illuminating power. For the amyl acetate photometric experiments of A. Voller, see Elektrot. Zts. 1891, **12**, 122, 177. For obituary of Hefner-Alteneck see J. Gas Light. 1904, **85**, 85. For a description of Harcourt's standard pentane lamp see Deut. Industrietg. 1888, 256; Industriebl. 1888, 335; Chem. Tech. Rep. 1888, **27**, II, 82.
3. J. Gasbel. 1886, **29**, 1022; 1891, **34**, 342, 515. J. Gas Light. 1884, **44**, 1036; 1887, **49**, 201.
4. J. Gasbel. 1891, **34**, 509; results of the technical examination of amyl acetate for suitability in the Hefner lamp.
5. Elektrochem. Zts.; abst. J. Gas Light. 1909, **107**, 312. Comparison of Hefner, Carcel and Harcourt pentane lamps.
6. J. Gasbel. 1891, **34**, 512; abst. J. Gas Light. 1891, **58**, 572; Chem. Ztg. Rep. 1891, **15**, 313. For standardizing the Hefner lamp see J. Gasbel. 1892, **35**, 428, 431; 1893, **36**, 341. For source of supply of officially standardized Hefner lamp see J. Gasbel. 1893, **36**, 450.
7. J. Gasbel. 1891, **34**, 129. See also W. Butterfield, J. Haldane and A. Trotter, J. S. C. I. 1941, **30**, 1005.
8. J. Gasbel. 1889, **32**, 733; comparison of spermaceti candle and Hefner lamp.
9. J. Gasbel. 1891, **34**, 516. For sensitometric use of the amyl acetate lamp, see E. English, Phot. Mitth. 1901, **38**, 157; Jour. Phot. Suppl. 1901, **43**, 43; Phot. Centr. 1901, **7**, 268.
10. J. Gasbel. 1900, **43**, 705; abst. Wag. Jahr. 1900, **46**, I, 72. For

Löwenherz,¹ O. Lummer,² O. Lummer and E. Brodhun,³ E. Liebenthal,⁴ Laporte,⁵ F. Martens,⁶ C. Paterson,⁷ W. Schiele,⁸ H. Strache,⁹ and W. Williams,¹⁰ and others.¹¹ Amyl acetoacetate,¹²

comparison of Hefner lamp with the Carcel lamp of Laporte, see J. Gasbel. 1898, **41**, 625. H. Kruss (J. Gasbel. 1887, **30**, 817; abst. J. Gas Light 1887, **50**, 791; Centr. Elektr. 1887, **8**, 617) has described an apparatus for facilitating the measurement of the height of the flame of the amyl acetate lamp

1. J. Gasbel. 1890, **33**, 659, 1891, **34**, 509. He compared the luminosity of various commercial amyl acetates (J. Gasbel. 1891, **34**, 510), and their effect on the standardization of the Hefner lamp (J. Gasbel. 1891, **34**, 489, 509; abst. Chem. Ztg. Rep. 1891, **15**, 312). • For detailed directions for standardizing, see J. Gasbel. 1891, **34**, 431, also report of Physikalisch-Technische Reichsanstalt for 1901 on certification of these lamps with optical flame measurers, compensating wicks and sighting eyepieces (J. Gas Light 1902, **80**, 397), and the report of H. von Helmholtz, J. Gas Light 1893, **62**, 81.

2. J. Gasbel. 1889, **32**, 768, 1890, **33**, 658.

3. Comparison of the German Verein candle and the Hefner lamp, J. Gasbel. 1890, **33**, 315, 319, 571, Instrum. Kunde, 1890, **10**, 119.

4. J. Gasbel. 1887, **30**, 814, Centr. Elektr. 1887, **9**, 614, J. Gas Light 1896, **67**, 124. For exhaustive comparison of Hefner, Harcourt and Carcel lamps, see E. Liebenthal, J. Gas Light 1906, **95**, 102, abst. J. S. C. I. 1906, **25**, 746.

5. According to J. Gas Light 1907, **99**, 315, 1 Carcel = 10.75 Hefner's = 0.98 Vernon-Harcourt. 1 Hefner = 0.993 Carcel = 0.0915 Vernon-Harcourt. 1 Harcourt = 1.02 Carcel = 10.95 Hefner's.

6. Verh. deut. phys. ges. 1900, **2**, 108; abst. J. Gasbel. 1900, **43**, 582. See also J. Gasbel. 1891, **34**, 265.

7. J. Gas Light. 1907, **99**, 232, 313. As the result of an extended series of comparisons, Paterson concludes (Nat. Physical Lab., Collected Researches, 1908, **3**, 49-96, abst. J. S. C. I. 1908, **27**, 553) that the Hefner and pentane lamps are much more constant than the Carcel lamp, and that, as between the pentane and Hefner lamps, the whiter light of the former (11 times that of the Hefner), together with its greater ease of adjustment when making observations, greatly outweigh the advantages attaching to the Hefner lamp by reason of its simpler construction and the smaller correction required for changes in barometric pressure.

8. J. Gasbel. 1889, **32**, 759; 1890, **33**, 593, 596, Jahr. Chem. 1891, **44**, 2784. For comparative experiments between the Siemens-Hefner lamp and the Kruss-Hefner lamp, see S. Schiele, J. Gasbel. 1890, **33**, 593.

9. J. Gas Light 1911, **115**, 359; he devised a method of facilitating the setting of the height of the flame in the Hefner lamp. For determination in amyl acetate of the total radiation, the ratio of the light radiation to the total radiation by means of a compensating pyrheliometer, see J. Gas Light. 1902, **80**, 1465.

10. J. S. C. I. 1885, **4**, 262. See also E. Ott and W. Butterfield, J. Gas Lighting, 1915, **132**, 378; abst. J. S. C. I. 1915, **34**, 1237.

11. H. Bunte, J. Gasbel. 1886, **29**, 1022. E. English, Phot. Corres. 1901, **38**, 324; Archiv. Wiss. Phot. 1901, **9**, 279. Nichols, Electric World, **44**, 474; abst. Fort. der Elektrotech. 1904, **18**, 748. J. Schiele, J. Gasbel. 1890, **33**, 591. F. v. Hefner-Alteneck, J. Gasbel. 1891, **34**, 349; Electrotech. Zts. 1891, **12**, 177, 194, 323. A. Voller, Electrotech. Zts. 1891, **12**, 122, 193. A. Bannow, Electrotech. Zts. 1891, **12**, 205. L. Löwenherz, J. Gasbel. 1891, **34**, 594. Electrotech. Zts. 1884, **5**, 20. J. Gasbel. 1884, **27**, 73; 1886, **29**, 3; 1887, **30**, 489. Jahr. Chem. 1891, **44**, 2784, 2786. Zts. Instrumentenkunde, 1893, 258; abst. Wag. Jahr. 1894, **40**, 3, 150. J. Phot. Suppl. 1901, **48**, 43. Phot. Centr. 1901, **7**, 268.

12. C. Borgmeyer, U. S. P. 507964, 1893. Cf. G. Ponzio and O. Prandi, Gaz. chim. ital. 1898, **28**, II, 279; abst. Chem. Centr. 1898, **68**, II, 966.

chloracetate¹ and acetosalicylate² have been patented as cellulose ester solvents. The assay of amyl acetate has been well worked out.³

Alkyl Esters. Other alkyls with paraffin acid radicals have not proven of equal technical value to amyl acetate,⁴ although amyl formate⁵ has been commercially used. The notes below

1. O. Amend, U. S. P. 371021, 1887, abst. *Wag. Jahr.* 1884, **30**, 1164; *J. A. C. S.* 1887, **9**, 179.

2. L. Paget, E. P. 7277, 1893, abst. *J. S. C. I.* 1893, **12**, 620; *Jahr. Chem.* 1893, **46**, 888.

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indicate sources of principal information concerning methyl

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formate, ethyl formate,¹ propyl formate,² and butyl formate;³

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¹ R. A. F. Spec D 14, Dec., 1917 (British).

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methyl propionate,¹ ethyl propionate,² propyl propionate,³

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 62, II, 169.

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CELLULOSE ESTERS

propyl,¹ butyl² and amyl valerianates,³ as cellulose esters solvents⁴

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Camphor is the most valuable and widely used of the solid or latent pyroxylin plastic colloiding agents. From the original work of A. Parkes, D. Spill and the Hyatt Brothers down to the present day, the original impetus given to this art by the discovery and application of camphor in conjunction with nitrocellulose, has ramified and developed primarily with the advancements of thermoplastic applications—of which natural camphor is the most important.

Natural Camphor.¹ The earlier researches of R. Boettger,² 1869, **40**, 898, 899; 1872, **43**, 688, *Jahr Chem* 1869, **22**, 526; *Ann* 1870, **153**, 135; *Zts Chem* 1869, **12**, 508. S. Young, *Sci Proc Roy Dublin Soc*, 1910, **12**, 374.

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 Z. Delalande,¹⁰ J. Liebig,¹¹ T. Martius,¹² Muncke,¹³ J. Pelouze,¹⁴

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• Camphor is the dextrorotatory¹ modification of the saturated ketone $C_9H_{16}CO$, obtained from camphor laurel, from the wood of which it is extracted by steam distillation followed by sublimation.² When pure, camphor is white, translucent and crystalline, soluble in about 700 parts of water,³ in 0.7 part ethyl alcohol, and readily soluble in acetone, methyl, ethyl and amyl acetates and in chloroform. Camphor is also an excellent solvent.⁴ It is at least quadrimorphic.⁵ The constitution of

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camphor has been investigated by L. Balbiano,¹ M. Ballo,² A. Behal,³ L. Bouveault,⁴ J. Bredt,⁵ J. Bredt and K. Burkheiser,⁶ F. Flavitzky,⁷ A. Kekule,⁸ A. Lapworth,⁹ J. Marsh and A. Hart-ridge,¹⁰ W. Noyes,¹¹ W. Perkins,¹² vapor pressure by R. Allen,¹³ the speed of volatilization by P. Villiard¹⁴ and C. La Wall,¹⁵ molecular weight by E. Beckmann and G. Schliebs,¹⁶ and purification methods by Suzuki Shop.¹⁷

Camphor oil is a solvent of some forms of cellulose esters, and has been extensively investigated.¹⁸ Combinations of cam-

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18. E. Dowzard, *Chem and Drug* 1902, **61**, 520, abst. *J. S. C. I.* 1902, **21**, 1244. L. Gans, *Chem Rev Fett and Harz Ind* **4**, 304; abst. *Chem. Centr.* 1898, **69**, I, 289. K. Kafuku, *J. Chem Ind. Tokyo*, 1916, **19**, 815; abst. *J. S. C. I.* 1916, **35**, 1178. R. Kayser, *Bayer Gewerbl* 1888, 212; abst. *Wag. Jahr.* 1888, **34**, 1161. J. Liverseege, *Chem and Drug*, 1901, **58**, 167; abst. *J. S. C. I.* 1901, **20**, 289. P. Macewan, *Pharm. J.* 1885, 1045; abst. *Dingl. Poly* 1886, **259**, 244. E. Parry, *Chem and Drug*, 1902, **61**, 520; abst. *J. S. C. I.* 1902, **21**, 1244. L. Sarason, *D. R. P.* 183190; abst. *J. S. C. I.* 1907, **26**, 1065; *Zts ang. Chem.* 1907, **20**, 1247; *Chem. Zentr.* 1907, **78**, II, 1036. F. Semmler and I. Rosenberg, *Ber.* 1913, **46**, 768; abst. *C. A.* 1913, **7**, 1720. N. Sugiyama, *Schimmels Rept.* 1902, 16; abst. *J. S. C. I.*

phor with other solids and liquids often result in the formation of fluid mixtures. Such are mixtures of camphor with oils,¹ phenol,² menthol,³ salol (camphol),⁴ chloral⁵ and chloral hydrate,⁶ and naphthalene,⁷ and their use as camphor substitutes in pyroxylin plastics have been advocated.

Artificial Camphor. The term "artificial", as applied to camphor, is not synonymous with "synthetic,"¹⁸ for while synthetic camphor is also artificial, the reverse is not the case. Artificial camphor is the name applied to *d*-pinene hydrochloride less often to the hydrobromide⁹ obtained by passing dry HCl gas into dry French or American oil of turpentine.

Pinene,¹⁰ terpin,¹¹ terpin hydrate,¹² hydrated pinene¹³ or terpine alcohols,¹⁴ when treated with HCl form a snow-like solid, which when purified, becomes the artificial camphor of commerce. The processes of W. Bentley, C. Weizmann and Clayton Aniline Co.,¹⁵

1902, **21**, 1551 A. Tschirch and H. Shimasawa, *Arch. der Pharm.* **240**, 257, abst. J. S. C. I. 1902, **21**, 1037, *Chem. Centr.* 1902, **73**, II, 133. H. Yoshida, J. C. S. 1885, **47**, 779. Schimmel's Rept. 1908, 25, abst. J. S. C. I. 1908, **27**, 709.

1. *Pharm. Centrallh.* 1902, **44**, 610, *Pharm. J.* 1903, **70**, 2, abst. J. S. C. I. 1903, **22**, 168.

2. R. Kremann, F. Wischo and R. Paul, *Monatsh.* 1915, **36**, 911, abst. J. S. C. I. 1916, **35**, 488. E. Leger, *Compt. rend.* 1890, **9**, 1149, abst. *Compt. rend.* 1890, **111**, 109. C. Roehr, *Pacific Pharm.* **7**, 281, abst. C. A. 1914, **8**, 2028. Schaefer, *Apoth. Ztg.* **5**, 657. J. Wood and J. Scott, *Proc. Chem. Soc.* 1910, 194, J. C. S. 1910, **97**, 1573, abst. *Drug Circ.* 1911, **55**, 39.

3. *Bull. Amer. Pharm. Assoc.* 1909, **4**, 55.

4. *Western Drug.* 1892, 16, abst. *Proc. Amer. Pharm. Assoc.* 1892, **40**, 1028.

5. Haarst, *Nieuw Tijdsch. Pharm. Nederl.* 1887, 179, abst. J. S. C. I. 1887, **6**, 681.

6. T. Brown, *Pharm. J. Trans.* (3), **4**, 729, abst. J. C. S. 1874, **27**, 723.

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9. P. Genyresse and P. Faivre, *Compt. rend.* 1903, **137**, 130, abst.

• J. S. C. I. 1903, **22**, 923.

10. C. Harries and H. v. Splawa Neyman, *Ber.* 1909, **42**, 879, abst. J. S. C. I. 1909, **28**, 440. Cf. N. Thurlow, U. S. P. 726783, 1903.

11. M. Bourdet, *J. Pharm. Chim.* 1911, **4**, 69.

12. J. Pougnet, F. P. 433710, 1911, abst. J. S. C. I. 1912, **31**, 257.

13. P. Barbier and V. Grignard, *Compt. rend.* 1907, **145**, 1425; *Bull. Soc. Chim.* 1909, **5**, 512, 1910, **7**, 342, 548, abst. J. S. C. I. 1908, **27**, 90, 1909, **28**, 672, 1910, **29**, 899.

14. F. P. 413282, 413289, 1909, abst. J. S. C. I. 1910, **29**, 1134. D. R. P. 228613, 1909; abst. C. A. 1911, **5**, 2156, *Zts. ang. Chem.* 1910, **23**, 2347. *Chem. Zentr.* 1910, **81**, II, 1695.

15. E. P. 7319, 1908; abst. J. S. C. I. 1909, **28**, 259.

W. Naschlod,¹ A. Hesse,² L. Nordheim,³ J. Woods,⁴ O. Nagel,⁵ J. Richardson,⁶ T. Bird,⁷ A. Dubosc and O. Picquet,⁸ Chem. Fabrik Uerdingen, Lienau & Co., and W. Naschold,⁹ J. Kon-dakow,¹⁰ Magnier and Brangier,¹¹ P. Magnier,¹² C. Mills,¹³ Soc. Anon. Fabrique Baloise de Produits Chim.,¹⁴ O. Schmidt,¹⁵ A. Sauvage,¹⁶ E. Rouxville,¹⁷ A. Mayer,¹⁸ J. Garcon,¹⁹ G. Le Roy,²⁰

1. U. S. P. 747629, 1903, abst. Mon. Sci. 1904, **61**, 85; Chem. Zts. 1904, **3**, 405; J. A. C. S. 1904, **26R**, 324.
2. U. S. P. 826166; D. R. P. 182943; E. P. 12633, 1910; Aust. P. 31674, 1907; Ber. 1906, **39**, 1127; abst. C. A. 1907, **1**, 118, J. C. S. 1906, **90**, i, 375, 376; J. S. C. I. 1906, **25**, 390, 1911, **30**, 815; Chem. Centr. 1905, **76**, II, 1750; 1907, **78**, I, 1470; Chem. Ind. 1907, **30**, 214; Chem. Ztg. 1907, **31**, 101; Chem. Ztg. Rep. 1907, **31**, 326; Chem. Zts. 1907, **6**, 151, Wag. Jahr. 1907, **53**, II, 121.
3. D. R. P. 64180, abst. J. S. C. I. 1893, **12**, 174; Wag. Jahr. 1892, **38**, 605, Chem. Centr. 1892, **63**, II, 1015; Zts. ang. Chem. 1892, **5**, 500.
4. E. P. 14328, 1897; F. P. 290843, 1899, Belg. P. 143872, 1899; abst. J. S. C. I. 1899, **18**, 1050.
5. U. S. P. 582221, 1897, 596662, 1898.
6. E. P. 18297, 1895, 3555, 1896, 5549, 1904; abst. J. S. C. I. 1896, **15**, 671; 1905, **24**, 208.
7. E. P. 18698, 1897; abst. J. S. C. I. 1898, **17**, 793.
8. F. P. 349852, 1904, abst. J. S. C. I. 1905, **24**, 857; Chem. Ztg. 1905, **29**, 792; Mat. Color. 1905, **9**, 275. See also O. Picquet, Belg. P. 235612, 1911.
9. D. R. P. 175662, abst. Wag. Jahr. 1906, **52**, II, 122, C. A. 1907, **1**, 1203; Chem. Centr. 1906, **77**, II, 1695; Chem. Ind. 1906, **29**, 575. E. P. 14189, 1903, F. P. 328009, 1902, D. R. P. 182044; abst. C. A. 1907, **1**, 2050; J. S. C. I. 1903, **22**, 1101; Chem. Zentr. 1907, **78**, I, 1293; Chem. Ztg. Rep. 1907, **31**, 177; Chem. Ind. 1907, **30**, 192, Wag. Jahr. 1907, **53**, II, 122. Cf. U. S. P. 747629, 1903.
10. Chem. Ztg. 1901, **25**, 609, abst. Chem. Centr. 1901, **72**, II, 416; J. C. S. 1901, **80**, i, 646. J. prakt. Chem. 1903, **67**, 280, abst. J. S. C. I. 1903, **22**, 438. J. prakt. Chem. 1907, **75**, 539, abst. C. A. 1907, **1**, 2705. Chem. Ztg. 1906, **30**, 497; abst. J. C. S. 1906, **90**, i, 520. J. Russ. Phys. Chem. Soc. 1910, **42**, 338; abst. Chem. Zentr. 1910, **81**, I, 2089; J. S. C. I. 1910, **29**, 899. D. R. P. 215336, 1908, abst. C. A. 1910, **4**, 644; Zts. ang. Chem. 1910, **23**, 46; Chem. Zentr. 1909, **80**, II, 1907; Wag. Jahr. 1909, **55**, II, 215; Chem. Zts. 1910, **9**, 1637. F. P. 397161, 1908, E. P. 7322, 1909; abst. J. S. C. I. 1909, **28**, 745.
11. F. P. 317804, 1902; abst. J. S. C. I. 1902, **21**, 1411; Mon. Sci. 1903, **59**, 120.
12. Belg. P. 157681, 1901.
13. India P. App. 473, 1901.
14. F. P. 377926, 1907; abst. C. A. 1909, **3**, 229.
15. Chem. Ind. 1906, **29**, 241; abst. Wag. Jahr. 1906, **52**, II, 125; Pharm. Era, 1907, **37**, 179; J. C. S. 1906, **90**, i, 868; Chem. Ztg. Rep. 1906, **30**, 204.
16. F. P. 389092, 1908; abst. J. S. C. I. 1908, **27**, 998.
17. U. S. P. 881827, 1908; E. P. 13023, 1907; Belg. P. 200494, 1907; F. P. 376269, 1906; abst. J. S. C. I. 1907, **26**, 988; 1908, **27**, 358, 765. E. P. 17773, 1906. F. P. 393310, 1908; abst. Mon. Sci. 1909, **70**, 434.
18. F. P. 393504, 1908; abst. J. S. C. I. 1909, **28**, 108.
19. Bull. Soc. Encour. Ind. National, 1906, **96**, 102; 1907, **171**, 451, 773; 1909, **166**, 606; 1910, **82**, 289. For the refractive exponent of artificial camphor see E. v. Kazay, Pharm. Post. 1908, **41**, 993; abst. Chem. Zentr. 1909, **80**, I, 309.
20. F. P. 392182, 1907; abst. J. S. C. I. 1909, **28**, 41.

H. Boistesselin and J. Verny,¹ M. Hoenicke and H. Berens,² and L. Voogt³ are illustrative. General processes are described by H. Kauffman,⁴ O. Piquet,⁵ P. Lipp,⁶ A. Haber,⁷ E. Darmois,⁸ J. Goldsmith,⁹ A. Colin,¹⁰ A. Collins,¹¹ G. Bruce,¹² Soc. Gen. pour la Fabrication des Matieres Plastiques,¹³ Badische Anilin u. Soda-fabrik,¹⁴ M. Hoenicke and H. Berens¹⁵ and F. Zeitschel.¹⁶ The methods of O. Dubosc,¹⁷ comprehend the use of pinene, sylvestrene, pentene, terpinolene, carvestrene, thujene, terpinene, phellandrene, bornylene or fencholene for the preparation of artificial camphor.

J. Liebig¹⁸ apparently was the first to investigate artificial camphor; I. Kondakoff¹⁹ has determined its constitution, and

- 1 F. P. 406005, 1908
- 2 E. P. 27317, 1913, abst. J. S. C. I. 1914, **33**, 439
- 3 Belg. P. 235381, 1911
- 4 Umschau, **20**, 309, abst. C. A. 1917, **11**, 1014
- 5 Belg. P. 235612, 1911. See also A. Dubosc and O. Piquet, Bull. soc. ind. Rouen, 1917, 444
- 6 Kunst. 1911, **1**, 341, 369. Ann. 1911, **382**, 265, abst. C. A. 1911, **5**, 3460
- 7 Rev. Sci. 1910, **86**, 449
- 8 Compt. rend. 1910, **150**, 925, abst. J. C. S. 1910, **98**, i, 398
- 9 E. P. 5429, 1907. See Drug Topics, 1909, **24**, 138.
- 10 Rev. Chim. 1909, **12**, 146, 192, abst. Jahr. Chem. 1909, **62**, 11, 983, Chem. Zentr. 1909, **80**, II, 1334
- 11 J. Ind. Eng. Chem. 1912, **4**, 514, abst. J. S. C. I. 1912, **31**, 734. See also Sci. Amer. 1903, **89**, 368, Suppl. **56**, 23, 319; abst. J. S. C. I. 1904, **23**, 75
- 12 Belg. P. 130896, 1897
- 13 F. P. 349815, 349816, 1904, abst. J. S. C. I. 1905, **24**, 750, Mat. Col. 1905, **9**, 209
- 14 E. P. 10915, 1911, abst. C. A. 1912, **6**, 2981, J. S. C. I. 1912, **31**, 302. Belg. P. 193506, 1906. D. R. P. 189867, 1905, abst. Chem. Zentr. 1908, **79**, I, 424.
- 15 E. P. 27317, 1913, abst. Kunst. 1914, **4**, 377.
- 16 U. S. P. 907941, E. P. 3176, 16532, 1907; F. P. 379430, 1907, D. R. P. 204163, 1906, Belg. P. 197799, 201459, 1907, Aust. P. 57916, 1913, abst. C. A. 1909, **3**, 693, 945; J. S. C. I. 1907, **26**, 1253, 1908, **27**, 139, 1909, **28**, 109, J. C. S. 1909, **96**, i, 245, Zts. ang. Chem. 1908, **21**, 2474, Chem. Zentr. 1908, **79**, II, 1751, Chem. Ztg. Rep. 1908, **32**, 642; Chem. Ind. 1908, **31**, 712; Wag. Jahr. 1908, **54**, II, 103. See also G. Bouchardat and J. Lafont, Ann. Chim. Phys. 1888, **15**, 145, 1889, **16**, 236.
- 17 F. P. 361333, 1905; E. P. 8260, 8356-A, 1906; abst. J. S. C. I. 1906, **25**, 952; 1907, **26**, 551. F. P. 370293, 1906, and addition of Dec. 17, 1906; abst. J. S. C. I. 1907, **26**, 278; 1908, **27**, 296; Mon. Sci. 1908, **68**, 143. E. P. 14379, 1907; abst. J. S. C. I. 1908, **27**, 917. F. P. 383478, 1907; 382790, 1906; abst. Mon. Sci. 1909, **70**, 13, J. S. C. I. 1908, **27**, 246. E. P. 413, 1908; abst. J. S. C. I. 1908, **27**, 1176. U. S. P. 937928, 1909. Belg. P. 191273, 1906. In this connection see also A. Dubosc, Rev. prod. chim. 1918, **21**, 369; abst. C. A. 1919, **13**, 963.
- 18 J. Liebig, R. Blanchet and Sell, Ann. 1833, **6**, 267, abst. Berz. Jahr. Chem. 1835, **14**, 301; Z. Pharm. 1834, **20**, 224, 35f; Pogg. Ann. 1833, **29**, 133. See also M. Dumas, Ann. 1833, **6**, 245.
- 19 I. Kondakoff and E. Lutschinin, Chem. Ztg. 1901, **25**, 131, 609; abst. J. C. S. 1901, **80**, i, 282, 646.

G. Vavon,¹ the rotatory power. The celluloid of F. Callenburg² comprises nitrocellulose and turpentine chloride. G. Best has employed camphene as a waterproofing constituent in transparent signs.³ The chlorhydrochlorides of pinene and firpene,⁴ and the nitrates of dihydrocamphene and pinene hydrochloride⁵ offer possibilities as camphor substitutes in cellulose ester plastics.

Synthetic Camphor. The rapidly increasing consumption of camphor in the arts without a corresponding increase in production, especially in the celluloid industry, has stimulated men of research and reflection to focus their energies on the synthesis of this body, not only from the theoretical interest which is attached to the subject, but to the commercial emoluments as well.

By "synthetic" camphor is to be understood the body consisting essentially of the compound $C_{10}H_{16}O$, in chemical composition identical with natural camphor, except that the former is unaffected by light, while the latter is dextrogyrate. Synthetic camphor *does not* give the same results in celluloid manufacture as does the natural product. The synthetic production of camphor rests upon a knowledge of the molecular structure of natural camphor, and this has been supplied by numerous researches, such as the work of L. Balbiano,⁶ E. Beckman,⁷ G. Blanc,⁸ J. Brecht,⁹ J. Brecht and W. Perkin,¹⁰ J. Bruhl,¹¹ P. Cazeneuve,¹² L.

1. Compt rend 1910, **150**, 1428; abst J S C I 1910, **29**, 839

2. F P 322506, 1902, abst J S C I 1903, **22**, 377

3. E P 6099, 1911

4. G. Frankforter and F. Priary, J A C S 1906, **28**, 1461, abst J S C I 1906, **25**, 1107.

5. M. Konowalow and S. Kokina, J. Russ Phys. Chem. Soc 1902, **34**, 935, abst Chem Centr 1903, **64**, I, 512; J S C I 1903, **22**, 378.

6. Gaz chim ital 1896, **26**, I, 52, abst J C S 1896, **70**, i, 492. Reale Accad dei Lincei, 1905, J. Pharm. Chim. 1906, **23**, 397; J S C I 1906, **25**, 442. L. Bolviano and V. Paolini, Ber 1909, **36**, 3575, abst J. C. S 1904, **86**, i, 72.

7. Ann 1896, **289**, 362. J prakt Chem 1897, **55**, 14. Ber 1909, **42**, 485; abst C A 1909, **3**, 1023, J. C S 1909, **96**, i, 169

8. Compt rend. 1896, **123**, 749, 1897, **124**, 468; abst Bull Soc Chim 1896, **15**, 1191. Compt rend 1906, **142**, 1084, abst Chem Centr 1906, **77**, II, 108. Sci Amer 1910, **282**. Rev gén sci. 1906, **17**, 721, abst. C A 1911, **5**, 963. See also L. Bouveault, Compt rend 1893, **116**, 1067

9. Ber 1885, **18**, 2889. Chem Ztg 1911, **35**, 765, abst C A. 1911, **5**, 3574

10. Proc Chem Soc 1912, **28**, 57, J C S 1913, **103**, 2182; abst C A 1913, **7**, 2927, 1914, **8**, 1413

11. Ber 1902, **35**, 3510, abst J S C. I 1902, **21**, 1409. Ber. 1904, **37**, 2163; abst Chem Centr 1904, **75**, II, 222

12. Compt rend 1882, **94**, 1058, 1883, **95**, 589; 1884, **98**, 306; 1885,

Claisen and O. Manasse,¹ S. Hoogewerff and W. VapDorp,² G. Erreca,³ A. Etard,⁴ M. Forster,⁵ M. Forster and H. Holmes,⁶ C. Friedel and A. Combes,⁷ R. Furness and W. Perkin,⁸ H. Goldschmidt and L. Schulhof,⁹ M. Guerbet,¹⁰ M. Guerbet and A. Behal,¹¹ Haarman & Reimer,¹² A. Haller and A. Minguin,¹³ J. Marsh and J. Gardner,¹⁴ J. Kachler,¹⁵ F. Kipping,¹⁶ F. Kipping and W. Pope,¹⁷ W. Koenigs and A. Eppens,¹⁸ W. Koenigs and J. Hoerlin,¹⁹ G. Komppa,²⁰ A. Lapworth and F. Kipping,²¹ P. Lat-schinoff,²² P. Maissen,²³ S. Malmgren,²⁴ J. Marsh,²⁵ E. Marsh and

101, 438, 1887, **104**, 1522; 1892, **114**, 1012, 1893, **116**, 148, abst. Bull. Soc. Chim. 1881, **36**, 650; 1884, **41**, 285; 1887, **47**, 920, 1893, **9**, 30, 90, Chem. Ztg. Rep. 1893, **17**, 33.

1 Ann. 1892, **274**, 71, abst. Chem. Ztg. Rep. 1893, **17**, 110.

2 Rec. trav. Chim. Pays-Bas, 1893, **12**, 12, 23, 1895, **14**, 252, abst. Bull. Soc. Chim. 1896, **15**, 748.

3 Gaz. chim. ital. 1892, **22**, 109, abst. Chem. Ztg. Rep. 1893, **17**, 32.

4 Compt. rend. 1893, **116**, 1136; abst. Jahr. Chem. 1893, **46**, 1534.

5 J. C. S. 1897, **71**, 191, 1906, **89**, 225. Proc. Chem. Soc. 1901, 207, 1906, 31. Chem. Druggist, 1904, **64**, 289, abst. J. S. C. I. 1901, **23**, 266.

6 Eighth Inter. Cong. Appl. Chem. 1912, **6**, 115.

7 J. C. S. 1908, **93**, 242, 251; abst. C. A. 1908, **2**, 1446.

8 Bull. Soc. Chim. 1893, **9**, 5, 27; abst. J. C. S. 1893, **64**, i, 600.

9 J. C. S. 1914, **105**, 2024; abst. J. S. C. I. 1914, **33**, 983, C. A. 1914, **8**, 3784. J. C. S. 1913, **103**, 2225, abst. J. S. C. I. 1914, **33**, 101, C. A. 1914, **8**, 1413.

10 Ber. 1886, **19**, 708, abst. J. C. S. 1886, **50**, 557.

11 Bull. Soc. Chim. 1894, **11**, 426. Compt. rend. 1908, **147**, 70, abst. J. C. S. 1908, **94**, i, 661. Compt. rend. 1909, **148**, 98, 720, **149**, 934, abst. Bull. Soc. Chim. 1909, **5**, 415; J. Pharm. Chim. 1909, **29**, 321, C. A. 1909, **3**, 1161, 2144. Bull. Soc. Chim. 1919, **7**, 64, 68, abst. C. A. 1910, **4**, 1161, 1162. Compt. rend. 1918, **166**, 1049.

12 Compt. rend. 1896, **122**, 1493, abst. J. C. S. 1896, **70**, i, 652.

13 E. P. 20498, 1892; abst. J. S. C. I. 1893, **12**, 948.

14 Compt. rend. 1894, **118**, 690, 1896, **123**, 216, abst. J. C. S. 1894, **66**, i, 338; 1896, **70**, i, 695.

15 Chem. News, 1896, **74**, 279, abst. Chem. Centr. 1897, **68**, I, 98.

16 Ber. 1878, **11**, 460, 676, 1880, **13**, 487, 1881, **14**, 2262, 1886, **19**, 748. Sitz. Ber. Wern. Akad. **88**, 345; **9**, 126. J. Kachler and F. Spitzer,

Ber. 1880, **13**, 573, 615, 1472, 2236, 1881, **14**, 1405, 1882, **15**, 1443, 2336, 1883, **16**, 1311, 2311, 2524; 1884, **17**, 141, 443, 2400, 1885, **18**, 328.

17 J. C. S. 1896, **69**, 61, 913, abst. Jahr. Chem. 1896, **49**, 198.

18 J. C. S. 1897, **71**, 962, abst. Jahr. Chem. 1897, **50**, 1269.

19 Ber. 1893, **26**, 810, abst. Chem. Ztg. Rep. 1893, **17**, 132.

20 Ber. 1893, **26**, 811; abst. Chem. Ztg. Rep. 1893, **17**, 132.

21 Ber. 1903, **36**, 4332; abst. J. S. C. I. 1904, **23**, 78. Ann. 1909, **368**, 126. Ber. 1911, **44**, 863, abst. J. C. S. 1911, **100**, i, 388.

22 J. C. S. 1897, **71**, i, 1; abst. Jahr. Chem. 1897, **50**, 1275, 1377.

23 Ber. 1880, **13**, 1052, abst. J. C. S. 1880, **38**, 722.

24 Gaz. chim. ital. 1880, **10**, 280; abst. Ber. 1880, **13**, 1873, Jahr. Chem. 1880, **33**, 880.

25 Chem. Ztg. 1903, **27**, 221; abst. J. S. C. I. 1903, **22**, 438.

26 Proc. Roy. Soc. 1890, **47**, 6, abst. J. C. S. 1890, **58**, 995.

H. Coussins,¹ L. Masson and A. Reychler,² J. Minguin,³ C. Moureu,⁴ F. Nägeli,⁵ W. Noyes,⁶ W. Noyes and A. Patterson,⁷ G. Oddo,⁸ W. Perkin and J. Thorpe,⁹ G. Pertier,¹⁰ V. Pleissner,¹¹ A. Ramage,¹² A. Reychler,¹³ E. Rimini,¹⁴ F. Rochussen,¹⁵ W. Roser,¹⁶ H. Ruppe,¹⁷ R. Schiff,¹⁸ R. Schiff and J. Puliti,¹⁹ F. Semmler,²⁰ F. Spitzer,²¹ T. Swarts,²² F. Tiemann,²³ J. Tingle and E. Gorsline.²⁴

J. Bertram and H. Walbaum²⁵ found in 1892 that when camphene is heated with glacial acetic acid and 2% sulfuric acid, isobornyl acetate is produced in satisfactory amounts, and this opened an important commercial method for camphor production. In general refinement or elaboration of this method, other methods of camphene formation have been devised by A. Schmidt,²⁶ G.

1. J. C. S. 1891, **59**, 966; abst. J. S. C. I. 1891, **10**, 1023.
2. Bull. Soc. Chim. 1896, **15**, 965; abst. J. C. S. 1896, **70**, i, 620.
3. Compt. rend. 1892, **115**, 120, 1903, **136**, 751; abst. J. S. C. I. 1903, **22**, 509.
4. Bull. Soc. Chim. 1897, **17**, 552; abst. J. C. S. 1899, **76**, i, 68.
5. Ber. 1884, **17**, 805; abst. J. C. S. 1884, **46**, 1190.
6. Ber. 1895, **28**, 547; 1896, **29**, 2326; Amer. Chem. J. 1896, **18**, 685.
7. Amer. Chem. J. 1902, **27**, 425; abst. Chem. Centr. 1902, **73**, II, 366.
8. Cf. Amer. Chem. J. 1894, **16**, 503; abst. Chem. Centr. 1895, **66**, I, 50.
9. Gaz. chim. ital. 1892, **21**, 505; 1893, **23**, 70; abst. Chem. Ztg. Rep. 1893, **17**, 110.
10. J. C. S. 1897, **71**, 1169; abst. Jahr. Chem. 1897, **50**, 1309.
11. Compt. rend. 1894, **119**, 276; abst. J. C. S. 1895, **68**, i, 60.
12. Ann. 1891, **262**, 1; abst. J. C. S. 1891, **60**, 936.
13. U. S. P. 710893, 1902; E. P. 4200, 1901; abst. J. S. C. I. 1902, **21**, 188, 1411.
14. Bull. Soc. Chim. Belg. 1907, **21**, 71; abst. J. C. S. 1907, **92**, i, 275.
15. Belg. P. 129448, 1897.
16. Gaz. chim. ital. 1896, **26**, 502; 1909, **39**, II, 186, 196; abst. J. C. S. 1909, **96**, i, 725, 728.
17. Chem. Ztg. 1909, **33**, 694; abst. C. A. 1909, **3**, 2706.
18. Ber. 1885, **18**, 3112; abst. J. C. S. 1886, **50**, 249.
19. D. R. P. 307357, 1916; abst. J. S. C. I. 1918, **37**, 783; C. A. 1919, **13**, 1075.
20. Ber. 1880, **13**, 1402, 1406; abst. Gaz. chim. ital. **10**, 317, 332; J. C. S. 1880, **38**, 892, 1402.
21. Gaz. chim. ital. 1881, **11**, 21.
22. Ber. 1883, **16**, 887; abst. Jahr. Chem. 1883, **36**, 998.
23. Ber. 1891, **24**, 201; 1900, **33**, 774; 1909, **42**, 246; abst. J. S. C. I. 1891, **10**, 382; Wag. Jahr. 1900, **46**, II, 275; J. C. S. 1909, **96**, I, 170.
24. Ber. 1878, **11**, 363; 1880, **13**, 1046; abst. J. C. S. 1878, **34**, 586; Jahr. Chem. 1880, **33**, 725; Wien. Akad. Ber. **82**, 596.
25. Ber. 1882, **15**, 1621; abst. J. C. S. 1882, **2**, 1300.
26. Ber. 1896, **29**, 119, 3006; 1897, **30**, 594.
27. Amer. Chem. J. 1908, **40**, 46; abst. Chem. Zentr. 1908, **79**, II, 874.
28. J. prakt. Chem. 1894, **157**, 1; abst. Wag. Jahr. 1895, **41**, 728.
29. 1894, **40**, 729.
30. D. R. P. 67255, 1892; abst. Wag. Jahr. 1893, **39**, 675; Ber. 1893, **26**, 418.
31. U. S. P. 989651, 1911.
32. E. P. 28028, 1907; abst. C. A. 1909, **3**, 1445; J. S. C. I. 1908, **27**, 1177.
33. E. P. 3750, 1908; abst. I. S. C. I. 1909, **28**,

- Hendersson and I. Heilbron,¹ G. Wagner, G. Ertzchikowsky and A. Ginsberg,² L. Montaland,³ H. Meerwein,⁴ A. Meyer,⁵ G. Henderson, M. Sutherland and W. Scotland,⁶ G. Harries and J. Palmen,⁷ W. Haworth and A. King,⁸ E. Buchner and W. Weigand,⁹ K. Auwers,¹⁰ Aktien Gesellschaft fur Anilin Fabrikation,¹¹ British

161. F. P. 385341, 1907; abst. J. S. C. I. 1908, **27**, 591; Mon. Sci. 1909, **70**, 13; 387053, 1908; abst. C. A. 1909, **3**, 1802; J. S. C. I. 1908, **27**, 832; Zts. ang. Chem. 1908, **21**, 2474; Mon. Sci. 1909, **70**, 14. D. R. P. 203792; abst. C. A. 1909, **3**, 476; J. S. C. I. 1909, **28**, 161; Zts. ang. Chem. 1908, **21**, 2474; Chem. Zentr. 1908, **79**, II, 1550, Chem. Ztg. Rep. 1908, **32**, 642; Chem. Ind. 1908, **31**, 712; Wag. Jahr. 1908, **54**, II, 104; Chem. Zts. 1909, **8**, 1274. D. R. P. 212893, 1906; abst. C. A. 1910, **4**, 236; Zts. ang. Chem. 1909, **22**, 2058; Chem. Zentr. 1909, **80**, II, 1024; Jahr. Chem. 1909, **62**, I, 966; Chem. Ztg. Rep. 1909, **33**, 548, Chem. Ind. 1909, **32**, 596; Wag. Jahr. 1909, **55**, II, 215. U. S. P. 1030334, 1912; abst. J. S. C. I. 1912, **31**, 702. E. P. 25453, 1907; abst. J. S. C. I. 1908, **27**, 1223. F. P. 384955, 1907; abst. C. A. 1909, **3**, 2351; J. S. C. I. 1908, **27**, 522; Mon. Sci. 1909, **70**, 105. E. P. 24806, 1907; abst. J. S. C. I. 1908, **27**, 1177. F. P. 383149, 1907; abst. C. A. 1909, **3**, 2350; Mon. Sci. 1909, **70**, 104. E. P. 28036, 1907; F. P. 385352, 1907; abst. J. S. C. I. 1908, **27**, 591. E. P. 3052, 1914. D. R. P. 203791, 1906; abst. C. A. 1909, **3**, 581; J. C. S. 1909, **96**, i, 246; Zts. ang. Chem. 1908, **21**, 2474; Chem. Zentr. 1908, **79**, II, 1750, Chem. Ztg. Rep. 1908, **32**, 642; Chem. Ind. 1908, **31**, 712; Wag. Jahr. 1908, **54**, II, 104; Chem. Zts. 1909, **8**, 1212. D. R. P. 203792; Aust. P. 39460, 1909. D. R. P. 212908; abst. Chem. Zentr. 1909, **80**, II, 1392; Jahr. Chem. 1909, **62**, I, 966, Chem. Ztg. Rep. 1909, **33**, 548; Chem. Ind. 1909, **32**, 663; Wag. Jahr. 1909, **55**, II, 215. Can. P. 111307, 111308, 1908. Belg. P. 203808, 1907; 205765, 1908.

1. Proc. Chem. Soc. 1911, 249. J. C. S. 1911, **99**, 1901.

2. Ber. 1896, **29**, 881, 886; abst. Wag. Jahr. 1896, **42**, 683. See also G. Wagner, S. Moycho and F. Zienkowski, Ber. 1904, **37**, 1032; abst. J. C. S. 1904, **86**, i, 438. F. Tiemann and F. Semmler, Ber. 1896, **29**, 3027; abst. Wag. Jahr. 1896, **42**, 683.

3. U. S. P. 999667, 1911; F. P. 412668, 1909; abst. J. S. C. I. 1910, **29**, 1036; 1911, **30**, 1138.

4. Ann. 1910, **376**, 152; 1913, **396**, 200, 1914, **405**, 129, abst. C. A. 1911, **5**, 89; 1913, **7**, 1875; 1914, **8**, 3183.

5. E. P. 28497, 1912; abst. J. S. C. I. 1914, **33**, 43. F. P. 451645, 1912; abst. J. S. C. I. 1913, **32**, 625; C. A. 1913, **7**, 3395, 4087. D. R. P. 272562, 272572, 1911; abst. C. A. 1914, **8**, 2923. See also E. P. 10783, 25453, 1907.

6. Proc. Chem. Soc. 1911, 211; 1912, **28**, 270; J. C. S. 1911, **99**, 1539; abst. C. A. 1911, **5**, 3677; J. S. C. I. 1912, **31**, 1146.

7. Ber. 1910, **43**, 1432; abst. J. C. S. 1910, **88**, i, 497. See also F. Semmler, Ber. 1909, **42**, 246; abst. J. C. S. 1909, **96**, i, 170.

8. Proc. Chem. Soc. 1912, 236; J. C. S. 1912, **101**, 1975; abst. C. A. 1913, **7**, 974.

9. Ber. 1913, **46**, 759; abst. C. A. 1913, **7**, 1719.

10. Ann. 1912, **387**, 240; abst. J. C. S. 1912, **102**, ii, 214.

11. • E. P. 22779, 1910. F. P. 396244, 1908; abst. J. S. C. I. 1909, **28**, 626. D. R. P. 205850, 206386, 1907; abst. C. A. 1909, **3**, 1671; J. S. C. I. 1909, **38**, 220, 2426; Zts. ang. Chem. 1909, **22**, 369, 606; Chem. Zentr. 1909, **80**, I, 702, 805; Jahr. Chem. 1909, **62**, I, 995; Chem. Ztg. Rep. 1909, **33**, 127, 176; Chem. Ind. 1909, **32**, 97, 154; Wag. Jahr. 1909, **55**, II, 210; Chem. Zts. 1909, **8**, 1260. F. P. 459922, 1913. Swiss P. 59412, 1912; abst. C. A. 1913, **7**, 3201; Chem. Ztg. 1913, **37**, 228.

and Continental Camphor Co.,¹ F. Koch,² T. Milošewski,³ S. Moycho and F. Zienkowski,⁴ A. Roesler,⁵ Fabrique de Produits Chimiques,⁶ K. Slawinski,⁷ A. Skita,⁸ E. Fromm, H. Hildebrandt and P. Clemens,⁹ J. McIntosh,¹⁰ O. Wallach,¹¹ J. Marsh and J. Gardner,¹² J. Riban,¹³ Rheinische Gummi u. Celluloidfabrik,¹⁴ Chem. Fabr. vorm. E. Schering,¹⁵ L. Tschougaeff,¹⁶ and including

1. E. P. 10227, 1910; F. P. 412668, 1909, abst. J. S. C. I. 1910, **29**, 1036, 1228; F. P. 418668, 1910; Belg. P. 224877, 1910; Ital. P. 109508, 1910.

2. U. S. P. 870829, 1907; E. P. 22810, 1906, abst. J. S. C. I. 1907, **26**, 343, 1253; F. P. 377311, 1907; D. R. P. 200619, 1907; abst. C. A. 1909, **3**, 1803; Zts. ang. Chem. 1909, **22**, 606; Chem. Zentr. 1909, **80**, I, 805; Jahr. Chem. 1909, **62**, I, 995; Chem. Ztg. Rep. 1909, **33**, 176; Chem. Ind. 1909, **32**, 134; Chem. Zts. 1909, **8**, 1179; Belg. P. 203699, 1907; Can. P. 109912, 1908.

3. J. Russ. Phys. Chem. Soc. 1907, **39**, 1395, abst. Chem. Zentr. 1908, **79**, I, 1180; J. C. S. 1908, **94**, i, 92.

4. Ann. 1905, **340**, 17, abst. J. C. S. 1905, **88**, i, 710. See also J. C. S. 1904, **86**, i, 438.

5. D. R. P. 205295, 1908, abst. C. A. 1909, **3**, 1575; J. S. C. I. 1909, **28**, 161; Zts. ang. Chem. 1909, **22**, 316; Chem. Zentr. 1909, **80**, I, 415; Jahr. Chem. 1909, **62**, I, 995; Chem. Ztg. Rep. 1909, **33**, 44; Chem. Ind. 1909, **32**, 49; Wag. Jahr. 1908, **54**, II, 107; Chem. Zts. 1909, **8**, 1153.

6. U. S. P. 890465, 891033, 1908, abst. J. S. C. I. 1908, **27**, 712, 769; E. P. 10783, 10784, 1907, abst. J. S. C. I. 1908, **27**, 139, 643; F. P. 375897, 386928, 1907; abst. J. S. C. I. 1907, **26**, 947, 1908, **27**, 769; C. A. 1909, **3**, 2345; Mon. Sci. 1909, **70**, 108; D. R. P. 204921, 218989, 1907, abst. C. A. 1909, **3**, 1446, 1910, **4**, 2029; J. C. S. I. 1910, **29**, 517; J. C. S. 1909, **96**, i, 247; Zts. ang. Chem. 1909, **22**, 316, 1910, **23**, 622; Chem. Zentr. 1909, **80**, I, 326; 1910, **81**, I, 971; Jahr. Chem. 1909, **62**, I, 995; Chem. Ztg. Rep. 1909, **33**, 44, 1910, **34**, 191; Chem. Ind. 1909, **32**, 49, 1911, **34**, 187; Wag. Jahr. 1908, **54**, II, 406; 1910, **56**, II, 250; Chem. Zts. 1910, **9**, 1598; Mon. Sci. 1914, **81**, 80; Belg. P. 205255, 205510, 1908; Aust. P. 388882, 1909.

7. Bull. acad. Sci. Cracow, 1905, 491, abst. J. C. S. 1906, **90**, i, 28. See also A. Shukoff, U. S. P. 900316, 1908, abst. J. S. C. I. 1908, **27**, 1084; E. P. 20526, 1906; F. P. 369794, 1906; abst. C. A. 1907, **1**, 2836; J. S. C. I. 1907, **26**, 990; Belg. P. 194778, 1906.

8. E. P. 13902, 13925, 1909; F. P. 411012, 1909; abst. C. A. 1911, **4**, 1825; J. S. C. I. 1910, **29**, 900, 1037; E. P. 18696, 1912; D. R. P. 230671, 1906; abst. C. A. 1911, **5**, 2699; Zts. ang. Chem. 1911, **24**, 572; Chem. Zentr. 1911, **82**, I, 521; D. R. P. 240671; abst. Wag. Jahr. 1911, **57**, I, 271; Belg. P. 221644, 1910; Aust. P. 50286, 1911.

9. Zts. physiol. Chem. 1903, **37**, 202, abst. J. C. S. 1903, **82**, i, 429.

10. J. McIntosh, E. P. 21031, 1896; abst. Mon. Sci. 898, **52**, 182.

11. Ber. 1892, **25**, 916; abst. Wag. Jahr. 1892, **38**, 605; J. pharm. chim. 1896, **3**, 465; abst. J. S. C. I. 1896, **15**, 570; Ann. 1902, **324**, 79; 1905, **343**, 40, 1908, **362**, 285, **363**, 1; abst. J. S. C. I. 1902, **21**, 1193; 1905, **24**, 1322; J. C. S. 1908, **94**, i, 813, 997; C. A. 1909, **3**, 311; Nachr. klg. Ges. Wiss. 1907, 375; abst. Chem. Zentr. 1908, **79**, I, 637.

12. J. C. S. 1891, **59**, 648; abst. Wag. Jahr. 1891, **37**, 738.

13. Pharm. J. Trans. (3), **6**, 64, abst. J. C. S. 1876, **29**, 245.

14. D. R. P. 264246, 1912; abst. J. S. C. I. 1913, **32**, 1087; C. A. 1914, **8**, 212.

15. Manufacture of camphene, U. S. P. 707270, 1902; E. P. 26620, 1901; F. P. 321746; D. R. P. 154107; Belg. P. 163658, 1902; abst. J. C. S.

the researches of Farbenf. vorm. F. Bayer & Co.,¹ among others.

So also the transformation of camphene into isobornyl esters, as the acetate, has been reported upon by such workers as G. Wendt,² A. Haller and Bechamp,³ J. Lutkehermölle,⁴ D. Tsakalotos and B. Papaconstantinou,⁵ P. Leemans,⁶ J. Kondakow and J. Schindelmeyer,⁷ J. Houben,⁸ P. Golubew,⁹ F. Fritzsche & Co.,¹⁰

1904, **86**, i, 1035, J. S. C. I. 1902, **21**, 1194, 1553, 1903, **22**, 229. U. S. P. 707271, E. P. 26619, 1901, F. P. 321851, D. R. P. 149791, Belg. P. 163659; Can. P. 84302, abst. J. C. S. 1904, **86**, i, 080, J. S. C. I. 1902, **21**, 1194, 1903, **22**, 43, Wag. Jahr. 1904, **50**, II, 130. Manufacture of camphene free from chlorine, U. S. P. 725890, E. P. 26618, 1901, F. P. 321861, D. R. P. 153924, Aust. P. 19308, Belg. P. 163683; Russ. P. 1388, 1906, abst. J. C. S. 1907, **86**, i, 904, J. S. C. I. 1902, **21**, 1553, 1903, **22**, 317, 618, 1905, **24**, 317; Wag. Jahr. 1904, **50**, II, 129. Camphene free from halogens, D. R. P. 197346, 197805, 1907, abst. J. S. C. I. 1908, **27**, 832, Chem. Zentr. 1908, **79**, I, 1811, 1864, Chem. Ind. 1908, **31**, 348, Wag. Jahr. 1908, **54**, II, 105, Zts. ang. Chem. 1908, **21**, 1618. Manufacture of borneol and isoborneol from camphor, U. S. P. 826165, 1906, E. P. 7315, 1909, F. P. 359547, 1905, D. R. P. 213154, Belg. P. 187846, 1905, abst. C. A. 1910, **4**, 236, J. S. C. I. 1906, **25**, 392, 827, Chem. Zentr. 1909, **80**, II, 1025, Chem. Ind. 1909, **32**, 597, Chem. Ztg. Rep. 1909, **33**, 548, Jahr. Chem. 1909, **62**, II, 166; Wag. Jahr. 1909, **53**, II, 215, Zts. ang. Chem. 1909, **22**, 2058. Manufacture of camphor from borneol, U. S. P. 994137, 1911, E. P. 26704, 1908, F. P. 398361, 1908, D. R. P. 161523, 165722, 271147, 271157, Belg. P. 213264, 1909, abst. C. A. 1910, **4**, 2186, 1914, **8**, 2457, J. S. C. I. 1909, **28**, 851, 1910, **29**, 113, Chem. Zentr. 1905, **76**, II, 419, 1906, **77**, I, 617, Kunst. 1914, **4**, 154, 172, Wag. Jahr. 1906, **52**, II, 124. Process for compressing camphor into a form easily handled, F. P. 398881, 1909, E. P. 1532, 1909, Belg. P. 213667, 1909, abst. J. S. C. I. 1909, **28**, 814, 1063. Preparing camphor from the esters of isoborneol, U. S. P. 790601, E. P. 26779, 1904, F. P. 349398, Aust. P. 23242, D. R. P. 158717, abst. J. S. C. I. 1905, **24**, 750.

16. Bull. Soc. Chim. 1901, **26**, 298, abst. J. S. C. I. 1901, **20**, 832.

1. Holland. P. Appl. 229, 1913, abst. Chem. Ztg. 1913, **37**, 228.

2. D. R. P. 207888, 208636, 1907, abst. C. A. 1909, **3**, 2036, J. S. C. I. 1909, **28**, 543, Zts. ang. Chem. 1909, **22**, 683, 986, Chem. Zentr. 1909, **55**, I, 1208, 1442, Jahr. Chem. 1909, **62**, I, 967, 996, Chem. Ztg. Rep. 1909, **33**, 243, Chem. Ind. 1909, **32**, 184, Wag. Jahr. 1909, **55**, II, 214, Chem. Zts. 1909, **8**, 1345.

3. Chem. Ztg. 1910, **34**, 1098, abst. C. A. 1912, **6**, 599.

4. E. P. 14752, 1908; F. P. 392247, 1908, abst. J. S. C. I. 1909, **28**, 41, 960. D. R. P. 214042, 1907, abst. C. A. 1910, **4**, 86, Zts. ang. Chem. 1909, **22**, 2345; Chem. Zentr. 1909, **80**, II, 1392, Chem. Ztg. Rep. 1909, **33**, 608; Chem. Ind. 1909, **32**, 702, Wag. Jahr. 1909, **55**, II, 212, Chem. Zts. 1910, **9**, 1592.

5. J. pharm. chim. 1916, **14**, 97, 1918, **17**, 198, abst. C. A. 1916, **10**, 3068, 1918, **12**, 1548.

6. E. P. 1936, 1908, F. P. 386347, 1908; abst. C. A. 1909, **3**, 2351; J. S. C. I. 1908, **27**, 712, 917, Mon. Sci. 1909, **70**, 107. Belg. P. 197837, 197838, 197849, 201016, 201018, 201019, 1907, 211350, 213625, 1909.

7. J. prakt. Chem. 1907, **183**, 529, abst. C. A. 1907, **1**, 2705, J. C. S. 1907, **92**, I, 712.

8. Ber. 1906, **39**, 1700, abst. J. C. S. 1906, **90**, i, 440, Wag. Jahr. 1906, **52**, II, 125; J. S. C. I. 1906, **25**, 557.

9. J. Russ. Phys. Chem. Soc. 1904, **36**, 1096; 1909, **41**, 1004; 1912, **44**, 1061; abst. J. C. S. 1905, **88**, i, 74, 1912, **102**, i, 787, Chem. Centr. 1905,

J. Hertkorn,¹ R. Pickard and W. Littlebury,² R. Seifert,³ Vereinigte Chininfabriken Zimmer & Co.,⁴ L. Weitz,⁵ J. Luetkehermoelle, L. Wetz and G. Ree,⁶ G. Bouchardat and J. Lafont,⁷ J. Kachler and F. Spitzer,⁸ C. Jackson and A. Menke,⁹ H. Immen-dorff,¹⁰ A. Haller,¹¹ A. Zimmermann,¹² F. Pond,¹³ J. Marcusson,¹⁴ A. Friedl, C. Weizmann and Clayton Aniline Co.,¹⁵ O. Florizoone,¹⁶ Langscheder Walzwerk und Verzinkereien Akt. Ges.,¹⁷ C. Glaser,¹⁸ Clayton Aniline Co.,¹⁹ C. Weizmann and Clayton Aniline Co.,²⁰

76, I, 95; 1910, **81**, I, 30, C. A. 1910, **4**, 1487, 1912, **6**, 3402, J. S. C. I. 1910, **29**, 173, 1006.

10. E. P. 27927, 1907, F. P. 385700, 1907, D. R. P. 207702, 1905, abst. C. A. 1909, **3**, 822, 2351, Zts. ang. Chem. 1909, **22**, 691; Chem. Zentr. 1909, **80**, I, 1207; Chem. Ztg. Rep. 1909, **33**, 243, Chem. Ind. 1909, **32**, 185; Chem. Zts. 1909, **8**, 1334.

1. U. S. P. 901293, 901708, 901709, 1908, abst. C. A. 1909, **3**, 580, J. S. C. I. 1908, **27**, 1131, 1170, 1176. E. P. 11248, 20050, 1908, abst. J. S. C. I. 1909, **28**, 746. D. R. P. Ann. H. 37298, 38309.

2. Proc. Chem. Soc. 1907, 262, J. C. S. 1907, **91**, 1973. J. C. S. 1912, **101**, 109, 121.

3. U. S. P. 779377, 1905, abst. Mon. Sci. 1905, **63**, 121.

4. U. S. P. 922538, 1909, E. P. 11574, 1906, 14699, 1911, D. R. P. 188703, 204922, abst. J. S. C. I. 1907, **26**, 113, 1909, **28**, 108, Zts. ang. Chem. 1909, **22**, 206; J. C. S. 1908, **94**, i, 351.

5. E. P. 14752, 1908, 11029, 1911, F. P. 392247, 1908, 429445, 1911; abst. J. S. C. I. 1909, **28**, 41, 960; 1911, **30**, 1231; 1912, **31**, 605. D. R. P. 243692; abst. C. A. 1912, **6**, 2293, Zts. ang. Chem. 1912, **25**, 702.

6. D. R. P. 214042, abst. Wag. Jahr. 1909, **55**, II, 212, Jahr. Chem. 1909, **62**, I, 967.

7. Compt. rend. 1886, **102**, 171, 1887, **104**, 693; 1894, **1**, 8, 248.

8. Ann. 1880, **200**, 340. Ber. 1880, **13**, 615, Wien. Akad. Ber. 1880, **80**, 197; 1883, **87**, 1133; **88**, 288. Apoth. Ztg. 1883, **4**, 380. Ber. 1884, **17**, 1036; abst. Chem. Ind. 1884, **7**, 125, 253, Chem. Tech. Rep. 1884, **23**, I, 218.

9. Amer. Chem. J. 1883, **5**, 270, Chem. Ind. 1883, **6**, 371, Apotheker. Ztg. 1883, **4**, 512.

10. Ber. 1884, **17**, 1036, abst. Jahr. Chem. 1884, **37**, 1065.

11. Compt. rend. 1882, **94**, 86; 1886, **103**, 64; 1887, **105**, 227; 1889, **108**, 1308; 1892, **115**, 97, 1893, **116**, 121, 1896, **122**, 446; 1898, **128**, 1270, abst. J. S. C. I. 1889, **8**, 1008, 1896, **15**, 372; Chem. Ztg. Rep. 1893, **17**, 32; Bull. Soc. Chim. 1896, **15**, 324, J. C. S. 1896, **70**, i, 448, Chem. Centr. 1899, **70**, II, 114.

12. E. P. 9008, 1905, abst. J. S. C. I. 1906, **25**, 89. E. P. 7315, 1909. D. R. P. 166722.

13. J. S. C. I. 1907, **26**, 383; abst. Chem. Zentr. 1907, **78**, II, 106. See Chem. Zentr. 1907, **78**, I, 853.

14. Chem. Ztg. 1909, **33**, 966, 985, abst. Wag. Jahr. 1909, **55**, II, 2220.

15. E. P. 21946, 1907; F. P. 389071, 1908; abst. J. S. C. I. 1908, **27**, 917.

16. E. P. 5513, 1908; abst. C. A. 1909, **3**, 3692; J. S. C. I. 1908, **27**, 917.

17. Belg. P. 212164, 1908. See also C. Ruder & Co., F. P. 453992; U. S. P. 1066758.

18. U. S. P. 864162, 1907; Re. 13001, 1909, 875062, 1907; 923967, 1909; abst. J. S. C. I. 1907, **26**, 1065; 1909, **28**, 745.

19. E. P. 8266, 10798, 1906; F. P. 375007, 1907; Add. 7938, 1907; abst. J. S. C. I. 1907, **26**, 223, 343, 1253, Mon. Sci. 1908, **68**, 85. E. P. 18280,

C. Ruder & Co. ¹ N. Thurlow, ² Badische Anilin & Soda Fabrik, ³
C. F. Boehringer & Soehne, ⁴ F. Bayer & Co., ⁵ Chemische Fabrik

1906; F. P. 379687, 1907; abst. J. S. C. I. 1907, **26**, 947, 1253. E. P. 21946, 1907; F. P. 389071, 1908; abst. J. S. C. I. 1908, **27**, 917, 958. F. P. 386552, 1908; abst. J. S. C. I. 1908, **27**, 712. Belg. P. 201286, 1907; 205537, 207287, 1908.

20. U. S. P. 896962, 1908; E. P. 5032, 1906; F. P. 369449, 1906; D. R. P. 197163, abst. J. S. C. I. 1907, **26**, 32, 113, Mon. Sci. 1908, **68**, 77; Zts. ang. Chem. 1908, **21**, 1375; Chem. Zentr. 1908, **79**, I, 1811, Chem. Ind. 1908, **31**, 284; Wag. Jahr. 1908, **54**, II, 102. U. S. P. 910978, 1909; E. P. 16605, 1907, F. P. 386552, 1908; abst. J. S. C. I. 1908, **27**, 712; 1909, **28**, 220, C. A. 1909, **3**, 2351, Mon. Sci. 1909, **70**, 107. E. P. 8266, 1906; abst. J. S. C. I. 1907, **26**, 223, F. P. 375007, 1907. E. P. 10798, 1906; Add. May 16, 1907, to F. P. 375007, 1907; abst. J. S. C. I. 1907, **26**, 343, 1253. E. P. 18280, 1906; F. P. 379687, 1907; abst. J. S. C. I. 1907, **26**, 947, 1253. E. P. 23875, 23875-A, 1906; abst. J. S. C. I. 1907, **26**, 838, 1028. D. R. P. 205849, 1907; abst. C. A. 1909, **3**, 1671, Zts. ang. Chem. 1909, **22**, 869, Chem. Zentr. 1909, **80**, I, 702, Jahr. Chem. 1909, **62**, I, 995, Chem. Ztg. Rep. 1909, **33**, 127; Chem. Ind. 1909, **32**, 97; Wag. Jahr. 1909, **55**, II, 211. D. R. P. 207155, 1907; abst. C. A. 1909, **3**, 1913, Zts. ang. Chem. 1909, **22**, 597; Chem. Zentr. 1909, **80**, I, 961, Jahr. Chem. 1909, **62**, I, 967, Chem. Ztg. Rep. 1909, **32**, 176, Chem. Ind. 1909, **32**, 184, Wag. Jahr. 1909, **55**, II, 212. Belg. P. 194467, 1906. Chem. Ztg. 1908, **32**, 941, abst. Wag. Jahr. 1908, **54**, II, 113.

1. U. S. P. 1066758, 1913, abst. C. A. 1913, **7**, 2994. E. P. 24779, 1912, abst. J. S. C. I. 1913, **32**, 450, Chem. Ztg. 1913, **37**, 163, 397. F. P. 449774, 1912, abst. C. A. 1913, **7**, 3395, abst. J. S. C. I. 1913, **32**, 508, Chem. Ztg. 1913, **37**, 228, Mon. Sci. 1914, **81**, 51. D. R. P. 250743, 1911; abst. C. A. 1913, **7**, 217, J. S. C. I. 1912, **31**, 1054, Zts. ang. Chem. 1912, **25**, 2238; Wag. Jahr. 1912, **58**, II, 294, Kunst. 1912, **2**, 359. Can. P. 146732; abst. C. A. 1913, **7**, 1787. U. S. P. 1105378, 1914; abst. J. S. C. I. 1914, **33**, 890. E. P. 2488, 1913; abst. J. S. C. I. 1913, **32**, 925. F. P. 453992, 1913; abst. C. A. 1914, **8**, 211, Mon. Sci. 1914, **81**, 10, J. S. C. I. 1913, **32**, 884. D. R. P. 268308, 1912, abst. Kunst. 1914, **4**, 116. Hung. Ann. R. 3126, abst. Chem. Ztg. 1913, **37**, 336. Belg. P. 250302, 253516, abst. Kunst. 1913, **3**, 234, 355.

2. U. S. P. 698761, 1902, 726783, 1903, 833095, 1906; abst. J. S. C. I. 1902, **21**, 791, 1903, **22**, 648; 1906, **25**, 1067. See also H. McKenna, E. P. 3365, 1896, abst. J. S. C. I. 1897, **16**, 354.

3. U. S. P. 833666, 1906, E. P. 16429, 1906, 5674, 1908, F. P. 368170, 1906, Add. dated Feb. 29, 1908; abst. J. S. C. I. 1906, **25**, 909, 1116, 1173; 1908, **27**, 832, 906. U. S. P. 903047, 1908, E. P. 6606, 1906; F. P. 364444, 1906, abst. J. S. C. I. 1906, **25**, 495, 909; 1908, **27**, 1177. F. P. 396244, 1908. D. R. P. 189867, 197161, 197162; abst. Zts. ang. Chem. 1908, **21**, 265, 1365, Chem. Zentr. 1908, **79**, I, 424, 1910, Chem. Ztg. Rep. 1908, **32**, 292; Chem. Ind. 1907, **30**, 619; 1908, **31**, 284; Wag. Jahr. 1907, **53**, II, 124; 1908, **54**, II, 103. Aust. P. 33450, 42598, 1910.

4. U. S. P. 727024, 727026, 1903; E. P. 12325, 1901, 26779, 1904; F. P. 340398; D. R. P. 126196, 158717, 161523; Aust. P. 10016, 23240, 23242, 1906; Belg. P. 157234, 181209; abst. J. S. C. I. 1902, **21**, 872; 1903, **22**, 709; Wag. Jahr. 1901, **47**, II, 266; J. C. S. 1905, **88**, i, 709; Chem. Centr. 1905, **76**, I, 841. U. S. P. 802792, 802793, 1905; E. P. 28035, 1904; F. P. 352888, 1905, Add. April 24, 1906; abst. J. S. C. I. 1905, **24**, 249, 985, 1188; 1906, **25**, 1006. D. R. P. 177290, 177291, 1904; 179738, 1905; 182300; Aust. P. 28949, 28950, 1907; 33453, 1908; abst. C. A. 1907, **1**, 1352, 2061; Zts. ang. Chem. 1907, **20**, 209, 1009; Chem. Zentr. 1906, **77**, II, 1790; 1907, **78**, I, 198, 1294; Chem. Ztg. Rep. 1907, **31**, 178; Chem. Ind. 1906, **29**, 574, 658; 1907, **30**, 192; Wag. Jahr. 1906, **52**, II, 125; 1907, **53**, II, 124; Chem. Zts. 1907, **6**, 54, 163. Belg. 183711, 183712, 1905; 191987, 1906. See also O.

auf Aktien,¹ L. Weitz,² are among those who have contributed.

Various methods have been proposed for economically splitting pinene hydrochloride into camphene, as heating with glacial acetic acid,³ sodium or lead acetate,⁴ glacial phosphoric acid,⁵ meta- or pyro-borates or -silicates,⁶ aniline,⁷ toluidine,⁸ sodium phenolate⁹ or naphtholate,¹⁰ calcium phenolate¹¹ or naphtholate,¹² KOH and MgO,¹³ sodium alcoholate,¹⁴ distillation with lime,¹⁵ heating with water under pressure,¹⁶ and heating with

Wallach, Ann. 1885, **230**, 228.

5. U. S. P. 1026913, 1912; D. R. P. 252158, 1911, abst. C. A. 1912, **6**, 1956; 1913, **7**, 402. F. P. 375590, 1907, abst. J. S. C. I. 1907, **26**, 947. Mon. Sci. 1908, **68**, 86. D. R. P. 191547, abst. J. C. S. 1908, **94**, i, 429.

6. U. S. P. 801483, 1905, E. P. 8207, 1905, F. P. 341513, 1904, D. R. P. 161306; Aust. P. 21683; Russ. P. 10160, 1905, abst. J. S. C. I. 1904, **23**, 881; 1905, **24**, 857, Chem. Centr. 1905, **76**, II, 180, Wag. Jahr. **51**, I, 127. See also F. P. 353065, 1905, abst. C. A. 1907, **1**, 381. E. P. 6652, 1904, abst. J. S. C. I. 1905, **24**, 209. U. S. P. 801485, 1905, E. P. 9550, 1905, D. R. P. 161523, abst. J. S. C. I. 1905, **24**, 902, 985, C. A. 1907, **1**, 383; J. C. S. 1906, **92**, i, 28, Wag. Jahr. 1906, **52**, II, 125. U. S. P. 930054, 1909, P. P. 1682, 1908; F. P. 389327, abst. J. S. C. I. 1908, **27**, 999, 1909, **28**, 42, 1006. E. P. 14408, 1908; F. P. 393478, 1908, D. R. P. 208487, abst. C. A. 1909, **3**, 2035, 2201, J. S. C. I. 1909, **28**, 108, 220, Zts. ang. Chem. 1909, **22**, 986; Chem. Zentr. 1909, **80**, I, 1282, Jahr. Chem. 1909, **62**, I, 967, Chem. Ztg. Rep. 1909, **33**, 243, Chem. Ind. 1909, **32**, 208, Wag. Jahr. 1909, **55**, II, 214, F. P. 353919, 1905, abst. J. S. C. I. 1905, **24**, 1082. D. R. P. 205263, 205264, Abst. C. A. 1909, **3**, 1575, Zts. ang. Chem. 1909, **22**, 263, 353, Chem. Zentr. 1909, **80**, I, 415, 1414, Jahr. Chem. 1909, **62**, I, 967, Chem. Ztg. Rep. 1909, **33**, 38; Chem. Ind. 1909, **32**, 49, Wag. Jahr. 1909, **55**, II, 77, 214, Chem. Zts. 1909, **8**, 1157, 1158. Aust. P. 39443, 39444, 1909. Belg. P. 183604, 184431, 184432, 1905, 206034, 1908. E. P. 27228, 1912, F. P. 321878, 1902, D. R. P. 290938, 1914; abst. J. S. C. I. 1905, **24**, 317, 1916, **35**, 655. Kunst. 1913, **3**, 19. U. S. P. 994437, 1911, F. P. 398361, 1909, abst. J. S. C. I. 1909, **28**, 854; 1911, **30**, 833.

7. F. P. 429445, E. P. 11029, 1911, abst. J. S. C. I. 1911, **30**, 1231, 1912, **31**, 605.

8. O. Wallach, Ann. 1885, **230**, 238, 1887, **239**, 6.

9. A. Behal, P. Magnier and C. Tisser, F. P. 349896, 1904, and First Addition, May 16, 1904, J. S. C. I. 1905, **24**, 857.

10. G. Wend. D. R. P. 207888, 1908, abst. Chem. Zentr. 1909, **80**, I, 1208.

11. A. Roesler, D. R. P. 205295, 1908, abst. Chem. Zentr. 1909, **80**, I, 415.

12. J. Bruhl, Ber. 1892, **25**, 146; abst. Chem. Centr. 1893, **64**, I, 197.

13. Akt. Ges. f. Anilinfabrikation, D. R. P. 205850, 1907.

14. E. Bergs, U. S. P. 833666, 1906, abst. C. A. 1907, **1**, 487, 498.

15. Badische Anilin u. Sodafabrik, E. P. 16429, 1906.

16. F. Koch, D. R. P. 206619, 1907, abst. Chem. Zentr. 1909, **80**, I, 805.

17. J. Goldsmith, E. P. 21171, 21180, 1906, abst. J. S. C. I. 1907, **26**, 1162, 1163.

18. J. Kachler, Ann., 1871, **159**, 281, 1872, **162**, 259; **164**, 75, 1873, **169**, 168; 1878, **191**, 143; 1879, **197**, 96.

19. O. Wallach, Ann., 1885, **230**, 238, abst. J. C. S. 1885, **48**, 550; 1886, **50**, 70.

20. J. de Montgolfier, Ann. Chim. Phys. 1878, **14**, 56, Ber. 1879, **12**,

sodium stearate, sodium benzoate or with sodium cinnamate.¹

It became evident, therefore, that for the synthesis of Bertram and Walbaum to attain commercial value, a more satisfactory method of conversion of pinene hydrochloride into camphene must be worked out. Since 1900 the following methods have been published, in which it is claimed that many of the objections of the older processes have been satisfactorily overcome. In eliminating the halogen acid from pinene hydrochloride, heating with aliphatic bases,² as methylamine, dimethylamine, ethylamine, or piperazine, piperine or piperidine; by heating with ammonia, either gaseous, aqueous or alcoholic;³ heating aqueous alkali in the presence of soap,⁴ the latter being a solvent of the pinene hydrochloride; heating with anhydrous phenolates,⁵ or an aqueous alkaline solution of the higher fatty acids;⁶ heating with an alkaline earth salt of a naphthol;⁷ or barium naphtholate;⁸ the alkaline earth metal (calcium or magnesium being generally employed) was intended to remove traces of chlorine from the prepared camphene, small amounts of chlorine being inadmissible for camphene used as a camphor in celluloid on account of the splitting off of hydrochloric acid and the discoloration if not ultimate decomposition of the celluloid. The oxidizing action of barium peroxide⁹ or sodium peroxide,¹⁰ heating with alkaline benzene,¹¹ or naphthalene sulphonates¹² to 150°-160°; heating

1710, 2155.

16. See Soc. Le Camphre, F. P. 408065, 1909.

1. O. Wallach, Ann. 1885, **230**, 239, D. Konowaloff, J. Russ. Phys. Chem. Soc. 1900, **32**, 78.

2. K. Stephan, U. S. P. 707270, 1902; abst. J. A. C. S. 1903, **25R**, 149.

3. K. Stephan, U. S. P. 707271, 1902; abst. J. A. C. S. 1903, **25R**, 149.

4. K. Stephan, U. S. P. 725890, 1903. K. Stephan and P. Hunsalz, U. S. P. 770940, 1904; 790607, 801483, 1905. K. Stephan and P. Rehlander, U. S. P. 801485, 1905.

5. Badische Anilin u. Sodafabrik, D. R. P. Anm. B. 40529, 1905; E. P. 16429, 1906.

6. Chem. Fabrik auf Actien, vorm. E. Schering, D. R. P. 153924, 1901; Basler Chem. Fabrik, E. P. 19960, 1906. D. R. P. 185402, 1906.

7. Badische Anilin u. Sodafabrik, E. P. 5674, 1908; Addn. to E. P. 16429, 1906; abst. J. S. C. I. 1906, **25**, 909.

8. F. Koch, E. P. 22810, 1906; F. P. 377311, 1907.

9. O. DuBosc, E. P. 8260, 1906, duplicating E. P. 8356, 1906; U. S. P. 937928, 1910.

10. Schmitz & Co., E. P. 25453, 1907; abst. J. S. C. I. 1908, **27**, 1223.

11. Chem. Fab. Sandoz, F. P. 386928, 1907; abst. C. A. 1909, **3**, 2351.

12. Chem. Fab. Sandoz, E. P. 10783, 1907; abst. J. S. C. I. 1908, **27**, 643.

directly with potassium carbonate,¹ α - or β -naphthylamine,² alkaline earth salts of organic sulphonamides (benzenesulphonamide, naphthyl sulphamide)³ or sodium *p*-toluene sulphonate⁴ have been advocated. To reduce the amount of bornyl- and iso-bornyl-acetate always produced in conjunction with the camphene, heating with basic lead acetate is recommended.⁵ The method of production by distilling bornyl chloride at 180°-210°, the distillate being refluxed to allow HCl to escape and camphene to be retained, as yet⁶ has proven too expensive.⁶ Other methods⁷ offer but little new in the matter of suggestion.⁸

The transformation of pinene hydrochloride and camphene into isoborneol has involved much ingenuity and patience in the selection of suitable oxidizing agents and in the control of the process of oxidation that the maximum yield may be attained. Nitric acid is most often used,⁹ being heated with the isoborneol at 37°-40° either with¹⁰ or without a catalyzer,¹¹ vanadic acid and ammonium vanadate may be employed, or nitrous acid introduced directly, whether by an acid containing the lower nitrogen oxides,¹² nitrous acid,¹³ or the addition of small amounts of sodium nitrite.¹⁴

1. Schmitz & Co., F. P. 384955, 1907, abst. C. A. 1909, **3**, 2351.
2. Act.-Ges. Anilinfabrikation, D. R. P. 206386, 1907, abst. Jahr. Chem. 1909, **62**, II, 995.
3. Chem. Fabrik auf Actien, vorm., E. Schering, D. R. P. 197346, 197805, 1907; abst. Chem. Zentr. 1908, **79**, I, 1811. See also D. R. P. 158717, 161523, 197346. Aust. P. 23210, 23242, 1905.
4. Chem. Fab. Sandoz, D. R. P. 204921, 1907; abst. Jahr. Chem. 1909, **62**, II, 995.
5. J. Basler & Co., U. S. P. 876310, 1908, E. P. 19961, 1906; D. R. P. 212901, 1904, Aust. P. 30845, Ital. P. 117768, 1911. I. Ach., U. S. P. 802792, 802793, 1905.
6. C. Glaser, U. S. P. 923967, 1908, cf. A. Wack, U. S. P. 898942, 808043, 1908; F. P. 385700, 1907.
7. R. Ellis, E. P. 10784, 1907; F. P. 375897, 1907, abst. J. S. C. I. 1907, **26**, 947. A. Bischler and A. Basselli, U. S. P. 876310, 1908; E. P. 19960, 1906, D. R. P. 193301. Chem. Fab. Sandoz, E. P. 10783, 1907, F. P. 386928, 1907. O. Billeter, U. S. P. 891033, 1908, F. P. 376897, 1907.
8. C. Weizmann, U. S. P. 896962, 1908, E. P. 5032, 1906, 16605, 1907; F. P. 386552, 1908; D. R. P. 197163, 1908. See also J. Tafel, U. S. P. 727024, 1903 (manufacture of camphidon); U. S. P. 727026, 1903 (camphidine).
9. Basler Chem. Fabrik, E. P. 1948, 19857, 1907, abst. J. S. C. I. 1907, **26**, 343, 838. See also Chem. Fab. Sandoz, D. R. P. 218989, 1907.
10. G. Ellis, E. P. 10407, 1906, abst. J. S. C. I. 1906, **25**, 1002.
11. G. Austerweil, E. P. 18047, 1908; F. P. 392011, 1908. D. R. P. 211799, 217555, 1908. A. Wack and Verona Chem. Co., U. S. P. 898943, 1908.
12. C. Philipp, U. S. P. 849018, 1907; abst. C. A. 1907, **1**, 1760, 1784.
13. Basler Chem. Fabrik, F. P. 377926, 1907; abst. Mon. Sci. 1908, **69**, 145.
14. Chem. Fab. v. Heyden, F. P. 365974, 1906; abst. Mon. Sci. 1907, **67**, 96.

Another method proposed consists in leading a chloroformic solution of isoborneol through nitrous acid gas, the fluid being saturated until it turns bluish green on cooling, while the slightly colored oil which subsides is changed into camphor upon the addition of water.¹ Where chromic acid is used as the oxidizing agent² the isoborneol is first dissolved in a nonoxidizing immiscible solvent.³ Where some form of chlorine is the oxidizer an aqueous solution of the gas is usually preferred,⁴ care being taken that the chlorine is not in excess, the isoborneol being either finely pulverized or previously dissolved in benzene,⁵ the chlorine being in the nascent state or nearly so.⁶ A final oxidation with small amounts of manganese dioxide⁷ or a catalyzing agent as iron or cobalt⁸ has been recommended. In order to modify the action, the introduction of cooled air or carbon dioxide may be necessary, if the reaction proceeds too energetically.⁹ The tendency toward the production of condensation products is said to be reduced by the addition of small amounts of sulphanilic acid during the oxidation process.¹⁰

Electrolytic oxidation, in presence of catalytic oxidizing agents, 5% sodium hydroxide¹¹ solution being the electrolyte, has been proposed, or the isoborneol may be suspended in a solution of an alkaline chloride,¹² magnesium carbide, ferromanganese¹³ ferrochrome, or superoxides¹⁴ have also been advocated. Sodium

1. C. F. Boehringer & Sohne, D. R. P. 177290, 177291. Aust. P. 28949, 28950, 33453, 1908. D. R. P. 179738, 182300, 1904.

2. A. Verley, E. Urban and A. Feige, U. S. P. 907428, 908171, 1908, E. P. 14549, 14550, 1907, F. P. 383557, 383558, 1907, D. R. P. 207156, 1907. Schmitz & Co., F. P. 383419, 385341, 1907. A. Boulé, E. P. 5513, 1908.

3. A. Friedl and C. Weizmann, E. P. 21946, 1907.

4. C. F. Boehringer & Sohne, D. R. P. 177290, 177291, 1904, First Addn. 179738, 1905. See also I. Kondalow, First Addn. dated Aug. 10, 1909, to F. P. 397161, 1908. E. P. 7322, 1909. D. R. P. Ann. H. 38309, 1902. U. S. P. 901293, 1908. D. R. P. Ann. H. 37298.

5. J. Hertkorn, E. P. 20050, 1908. U. S. P. 901708, 1908.

6. J. Hertkorn, F. P. 352888, 1905; abst. Mon. Sci. 1906, **65**, 110.

7. Basler Chem. Fabrik, F. P. 362956, 1906; abst. Mon. Sci. 1907, **67**, 91.

8. C. Glaser, U. S. P. Reissue, 13001, Aug. 3, 1908.

9. C. F. Boehringer & Sohne, D. R. P. 177291, 1904. D. R. P. 214962, 1906.

10. F. Fritzsche & Co., E. P. 27927, 1907; abst. J. S. C. I. 1908, **27**, 958. F. P. 385700, 1907; abst. J. S. C. I. 1908, **27**, 644. D. R. P. 207702, abst. Wag. Jahr. 1909, **55**, II, 216.

11. W. Simmons, Chem. and Drug. 1908, **73**, 198.

12. C. Glaser, U. S. P. 875062, 1907; abst. C. A. 1908, **2**, 1204.

13. Basler Chem. Fabrik, F. P. 387539, 1907; abst. Mon. Sci. 1909, **71**, 14.

14. Schmitz & Co., E. P. 3750, 1908; abst. J. S. C. I. 1909, **28**, 161.

peroxide,¹ cupric oxide,² heating with finely divided copper,³ or copper gauze,⁴ and ozone,⁵ all having been found more or less successful.

As modifications and refinements of the above mentioned processes, may be mentioned the claimed improvements of the Ampere Electrochemical Co.,⁶ K. Wideen and Carbon Hydrate Chemical Co.,⁷ Chemische Fabrik von Heyden Akt.-Ges.,⁸ Basler Chemische Fabrik,⁹ A. Behal,¹⁰ J. Marsh and R. Stockdale,¹¹

- F. P. 387053, 1908. D. R. P. 203792, 1907.
1. Schmitz & Co., F. P. 385352, 1907, abst. J. S. C. I. 1908, **27**, 591.
2. Schmitz & Co., F. P. 387053, 1907, abst. J. S. C. I. 1908, **27**, 832.
3. J. Goldsmith, E. P. 17573, 1906, abst. J. S. C. I. 1907, **26**, 777.
4. Chem. Fabrik auf Actien, vorm., E. Schering, F. P. 353919, 1905;
5. Chem. Fabrik auf Actien, vorm., E. Schering, F. P. 353065, 1905.
- E. P. 8297, 1905. C. Harris and H. Neresheimer, Ber. 1908, **41**, 38.
6. E. P. 14754, 1900; 2129, 1902, abst. J. S. C. I. 1901, **20**, 67; 1902, **21**, 722. F. P. 303812, 1900; Belg. P. 150337, abst. J. S. C. I. 1902, **21**, 1469.
7. R. P. 134553, Aust. P. 10344, 1902, 11344, 1903; Russ. P. 5675, 1901; abst. Wag. Jahr. 1902, **48**, II, 136; J. C. S. 1903, **84**, i, 502; Chem. Zentr. 1902, **73**, II, 975. Belg. P. 150293, 1901; 161248, 1902. Can. P. 76148, 76637, 1900. Norw. P. 10906. Rev. Prod. Chim., (3), **4**, 36; abst. J. S. C. I. 1901, **20**, 604.
8. E. P. 9340, 1903; abst. J. S. C. I. 1903, **22**, 880.
9. U. S. P. 779377, 1905; E. P. 26785, 1903, F. P. 3395 4, 1904; abst. J. S. C. I. 1904, **23**, 204, 680; 1905, **24**, 150. U. S. P. 849018, 1908; 919762, 1909; E. P. 10899, 12630, 24830, 1906, F. P. 365816, Add. 6354; abst. J. S. C. I. 1906, **25**, 714, 1006, 1116; 1907, **26**, 67, 433; 1909, **28**, 544; C. A. 1909, **3**, 1802. E. P. 10407, 1906; F. P. 365974, 1906; abst. J. S. C. I. 1906, **25**, 1006. E. P. 12639, 1906; 22129, 1907; abst. J. S. C. I. 1908, **27**, 296. D. R. P. 175007, 1906; Aust. P. 30092; abst. J. C. S. 1907, **92**, i, 429; Zts. ang. Chem. 1907, **20**, 30; Chem. Centr. 1906, **77**, II, 1589; Chem. Ind. 1906, **29**, 513; Wag. Jahr. 1906, **52**, II, 123. D. R. P. 178934; abst. C. A. 1907, **1**, 1352; Zts. ang. Chem. 1907, **20**, 1009; Chem. Zentr. 1907, **78**, I, 198; Wag. Jahr. 1906, **52**, II, 124; Chem. Zts. 1907, **6**, 36, Mon. Sci. 1909, **70**, 67. D. R. P. 184635, 185933, 187684, 189261; abst. C. A. 1907, **1**, 2654; Chem. Ind. 1907, **30**, 257, 569, 597; 1908, **31**, 139; Chem. Zentr. 1907, **78**, II, 434; Wag. Jahr. 1907, **53**, 123; J. C. S. 1908, **94**, i, 351. D. R. P. 194767, 196017, 208790, 288267, 1914; abst. Zts. ang. Chem. 1908, **21**, 1087; Chem. Zentr. 1908, **79**, I, 1436; Chem. Ztg. Rep. 1908, **32**, 234, Wag. Jahr. 1909, **55**, II, 213; J. C. S. 1908, **94**, i, 809; J. S. C. I. 1916, **35**, 356. Belg. P. 191819, 191888, 192523, 1906. Aust. P. 30092, 1907; 33484, 33485, 33720, 1908. See D. R. P. 13088, 67255, 134553, 157590, 177290, 177291, 161306, 161523, 182300.
10. U. S. P. 876137, 1908; E. P. 19960, 1906; F. P. 369257, 1906; abst. J. S. C. I. 1907, **26**, 67, 113, 343; 1908, **27**, 139; Mon. Sci. 1908, **68**, 76. U. S. P. 876310, 1908; E. P. 19961, 1906; F. P. 7217, Add. to 369257, 1907; D. R. P. 193301, abst. J. S. C. I. 1907, **26**, 778; 1908, **27**, 139; J. C. S. 1908, **94**, i, 429; Zts. ang. Chem. 1908, **21**, 944, Chem. Zentr. 1908, **79**, I, 988; Chem. Ztg. Rep. 1908, **32**, 81. E. P. 2520, 1906; F. P. 362956, 1906; abst. J. S. C. I. 1906, **25**, 335, 777. E. P. 9857, 1907; F. P. 377926, 1907; abst. J. S. C. I. 1907, **26**, 838, 1065. E. P. 19350, 1910. F. P. 387539, 1907; abst. J. S. C. I. 1908, **27**, 876; Mon. Sci. 1909, **70**, 14. D. R. P. 185402; abst. C. A. 1907, **1**, 2656; Chem. Zentr. 1907, **78**, II, 498; Chem. Ztg. Rep. 1907, **31**, 326; Wag. Jahr. 1907, **53**, II, 122. D. R. P. 185808, Russ. P. 14862;

O. Aschan,¹ Tardy,² A. Verley,³ A. Kuner & P. Millet,⁴ G. Austerweil,⁵ Societe Le Camphre.⁶

Further contributions to the subject have been made by many, among which may be recorded M. Berthelot,⁷ W. Alexejeff,⁸

abst C. A. 1908, **2**, 351; J. S. C. I. 1907, **26**, 1064, Zts. ang. Chem. 1907, **20**, 1541; Chem. Zentr. 1907, **78**, II, 1037, Jahr. Chem. 1905 08, 993, Chem. Ztg. Rep. 1907, **31**, 361; Wag. Jahr. 1907, **53**, II, 562. D. R. P. 212901, 1904; abst. C. A. 1910, **4**, 236; Zts. ang. Chem. 1909, **22**, 2105, Chem. Zentr. 1909, **80**, II, 1095; Jahr. Chem. 1909, **62**, I, 996, Chem. Ztg. Rep. 1909, **33**, 548; Chem. Ind. 1909, **32**, 664; Wag. Jahr. 1909, **55**, II, 216. Belg. P. 194392, 1906; 202495, 1907. Aust. P. 30845, 1907, 36703, 1909, 38100, 1909. Can. P. 110927. See also U. S. P. 802793, 1905; E. P. 9857, 1907; F. P. 365974, 1906; abst. J. S. C. I. 1905, **24**, 1188; 1906, **25**, 1002; 1907, **26**, 838. In this connection see J. Goldsmith and British Xylomite Co., E. P. 17573, 21180, 1906; 5429, 1907, abst. J. S. C. I. 1907, **26**, 777, 1163, 1908, **27**, 139. See E. P. 9008, 1905; 16429, 22810, 1906, F. P. 375897, 1907, abst. J. S. C. I. 1906, **25**, 89, 909; 1907, **26**, 343, 947.

10. U. S. P. 831028, 1906, E. P. 11512, 1905, F. P. 349970, 1904, abst. J. S. C. I. 1905, **24**, 855, 985, 1064. E. P. 10758, 10758A, 10758B, 1905, F. P. 4229, Add. to 349896, 1904, abst. J. S. C. I. 1905, **24**, 985, 1082. F. P. 361978, 1905, abst. Mon. Sci. 1908, **68**, 78. Belg. P. 184680, 184896, 1905. Aust. P. 38203, 1909. Compt. rend. 1894, **119**, 858.

11. J. C. S. I. 90, **57**, 961, abst. Ber. 1891, **24**, 155.

1. Ann. 1896, **290**, 185. Ber. 1906, **39**, 1447, abst. J. S. C. I. 1906, **25**, 487. Ber. 1908, **41**, 1092; abst. J. C. S. 1908, **94**, I, 428, Chem. Zentr. 1908, **79**, I, 1693. Ann. 1911, **383**, I, 39, **52**, abst. J. C. S. 1911, **100**, I, 794, 796, 777, C. A. 1911, **5**, 3577, 3580. Oefversigt af Finska Veterinärskaps Societätens Forhandlingar, 1911, **53**, Afd. A, No. 12, I, abst. C. A. 1912, **6**, 3414, J. C. S. 1912, **102**, I, 367; Chem. Zentr. 1912, **83**, I, 415. See also Asahi Camphor Refining Co., Ltd., Jap. P. 30605, 1917, abst. C. A. 1916, **10**, 2390.

2. J. pharm. chim. 1904, **95**, 57, abst. Chem. Zentr. 1904, **75**, II, 1043.

3. U. S. P. 907428, 1908; E. P. 14549, 1908, F. P. 383557, 1907, abst. J. S. C. I. 1907, **26**, 1295; 1908, **27**, 356, 1909, **28**, 108. U. S. P. 908171, 1908, E. P. 14550, 1907, F. P. 383558, 1907; abst. J. S. C. I. 1907, **26**, 1162, 1163, 1908, **27**, 356, 1909, **28**, 109. D. R. P. 207156, abst. C. A. 1909, **3**, 1913, Zts. ang. Chem. 1909, **22**, 597, Chem. Zentr. 1909, **80**, I, 961, Jahr. Chem. 1909, **62**, I, 967; Chem. Ztg. Rep. 1909, **33**, 176; Chem. Ind. 1909, **32**, 184, Wag. Jahr. 1909, **55**, II, 211. D. R. P. 220838, 1907, abst. C. A. 1910, **4**, 2547; Zts. ang. Chem. 1910, **23**, 1090, Chem. Zentr. 1910, **80**, I, 1564; Wag. Jahr. 1910, **56**, II, 252. E. P. 4326, 1901; abst. J. S. C. I. 1901, **20**, 603. Belg. P. 200966, 201965, 1907. Aust. P. 41806, 1910.

4. F. P. 381226, 1906; abst. J. S. C. I. 1908, **27**, 139.

5. U. S. P. 979247, 1910; E. P. 18047, 1908, F. P. 392011, 1908, abst. J. S. C. I. 1908, **27**, 1222, 1909, **28**, 745. U. S. P. 986038, 1911, E. P. 18049, 1908, F. P. 392159, 1908; abst. J. S. C. I. 1909, **28**, 41, C. A. 1909, **3**, 2998. D. R. P. 217555; abst. C. A. 1910, **4**, 1651; Zts. ang. Chem. 1910, **23**, 383, Chem. Zentr. 1910, **80**, I, 587; Chem. Ztg. Rep. 1910, **34**, 6; Chem. Ind. 1910, **33**, 83; Chem. Zts. 1910, **9**, 1705. Aust. P. 49729, 51012, 1911. Compt. rend. 1909, **148**, 1197; abst. C. A. 1909, **3**, 2146. In this connection see Compt. rend. 1891, **113**, 551; 1897, **126**, 755. Ann. Chim. Phys. 1889, **16**, 236. Ampere Electrochemical Co., D. R. P. 134553. Chemische Fabrik von Heyden, D. R. P. 175097, 178934. M. Zeitschel, F. P. 379430. Aust. P. 23240. D. R. P. 182300. F. P. 365974, 377920, 387539.

6. F. P. 408065, 408106, 1909; 452432, 1912; abst. Mon. Sci. 1914, **81**, 52. Can. P. 112552, 1908. See also R. Andreau, U. S. P. 1347071.

7. Indblätter, 1887, 111; abst. Chem. Tech. Rep. 1887, **26**, I, 269.

H. Armstrong and W. Tilden,¹ J. Bredt and M. V. Rosenberg,² J. Callenbach,³ W. Gossling,⁴ L. Kebler,⁵ A. Baselli,⁶ R. Breteau,⁷ C. Doremus,⁸ W. Darrah,⁹ W. Johnston,¹⁰ O. Kausch,¹¹ A. Reclaire,¹² V. Reko,¹³ A. v. Unruh,¹⁴ Berger,¹⁵ A. Heffter,¹⁶ C. Lutz,¹⁷ M. Schall,¹⁸ E. Richter.¹⁹

In connection with borneol, as throwing additional light on the synthesis of this complex body should be cited the work of H. Wuyts,²⁰ G. Neave,²¹ G. Henderson and W. Caw,²² O. Fernandez,²³ J. Aloy and V. Brustier,²⁴ E. Vanstone,²⁵ E. Deussen and A. Hahn,²⁶ W. Borsche and W. Lange,²⁷ L. Bauveault and G. Blanc,²⁸ J. Houben and H. Doescher,²⁹ F. Luedy,³⁰ E. Belloni,³¹ O. v. Sobbe,³²

Compt rend 1875, **80**, 1425; abst J C S 1875, **28**, 1259

8 • Bull Soc Chim 1881, **35**, 107, abst J C S. 1881, **40**, 438.

1. J C S 1879, **35**, 756 H. Armstrong, J C S 1896, **69**, 1397.

2. Ann 1896, **289**, 1, abst Bull Soc Chim 1896, **15**, 135.

3. Ber 1897, **30**, 639, abst J C S 1897, **72**, i, 271

4. Pharm Post 1905, 599.

5. Amer. J. Pharm 1907, **79**, 349, abst Chem Zentr. 1907, **78**, II, 984

6. Giorn Farm Trieste, 1907, 2, Repert pharm 1907, **19**, 125; abs J.

J. S. C. I 1907, **26**, 431.

7. J pharm chim 1907, **98**, 186 P Breteau and H Leroux, F. P. 409557, 1909

8. See F Pond, J S C I 1907, **26**, 388

9. Chem Eng 1909, **9**, 165, Chem News, 1909, **100**, 45

10. Merck's Rept 1910, **19**, 69

11. Kunst 1911, **4**, 1, 24, abst C A 1914, **8**, 988.

12. Chem Ztg 1912, **36**, 1125

13. Kunst 1911, **1**, 241.

14. Kunst 1913, **3**, 425

15. Schweiz Apoth Ztg 1915, **53**, 495, J Pharm 1916, 110. See also P. Golubew, J. Russ Phys Chem. Soc. 1904, **36**, 1096, abst Chem. Centr. 1905, **76**, I, 95.

16. Viertelschr Med öffentl Samtatsw, **49**, 5, abst C A 1915, **9**, 1970. Schweiz Apoth Ztg 1915, **53**, 102, abst C A 1915, **9**, 1664

17. Ber Klin Wochschr. 1915, **52**, 322, abst C. A. 1915, **9**, 1807

18. Kunst. 1915, **5**, 267

19. Apoth. Ztg. 1915, **30**, 14; abst. C. A. 1915, **9**, 1366.

20. Ber 1903, **36**, 863, abst J. C S 1903, **84**, i, 428

21. J C S 1912, **101**, 513, abst C A 1912, **6**, 2065

22. J C S 1912, **101**, 1416, abst C A 1913, **7**, 331, J S. C. I. 1912, **31**, 794

23. Ann Fis Quim 1907, **7**, 442; abst J C. S 1910, **98**, i, 399

24. Bull Soc Chim. 1911, **9**, 733. J. pharm chim 1914, **10**, 49, abst. J. S C I 1914, **33**, 806

25. J C S 1909, **95**, 595; 1910, **97**, 429; abst. C. A. 1909, **3**, 1713; 1910, **4**, 1564

26. Zts Riechu Geschmackstoffe, 1909, **1**, 25, abst J S C I. 1909, **28**, 440.

27. Ber 1906, **39**, 2346, 3268, abst. J. C S. 1906, **90**, i, 679; 868.

28. Compt rend 1905, **140**, 93; abst. J C S 1905, **88**, i, 222.

29. Ber 1906, **39**, 3503, abst J. C. S. 1906, **90**, i, 970

30. Pharm Zentralh 1908, **49**, 625; abst. J. S. C I 1908, **27**, 1130.

31. Boll chim farm **45**, 185; abst. Chem Centr. 1906, **77**, i, 1552;

A. Haller and F. March,¹ M. Forster and H. Atwell,² and R. Andreau.³

Likewise in respect to camphene, may be consulted the investigations of C. Grimaldi,⁴ W. Ipatiew and N. Matow.⁵ Camphene has been employed as a constituent of cements,⁶ varnishes⁷ and formaldehyde condensation compounds.⁸ J. Callen and R. Stusser⁹ have patented the use of nor-camphor. Borneol- and menthol- α -bromisovalerates,¹⁰ benzyl- and phenyl-borneols and -camphenes,¹¹ bornyl- toluene-*p*-sulfonate¹² are possibilities.

Camphor Substitutes. The successful substitution of camphor in the pyroxylin plastic industry, has, up to the present time, remained one of the unsolved problems of thermoplastic technology. Many substitutes have been proposed and some have been adopted, which for the production of specific effects are the equal of camphor when combined with pyroxylin. But for general moldable nitrocelluloses, no substitute has been found equal to the original.

There is no clear line of demarcation between camphor substitutes, ancillary gelatinizing agents, antacids, stabilizers, gelatinizing accelerators, colloiding thermoplastics, high boilers, activators, and supple-inducing bodies so that a clear-cut classification is impossible, for in their deportment towards nitrocellulose, many of the chemicals and chemical combinations, in their

J. C. S. 1906, **90**, i, 520

32 J. prakt. Chem. 1908, **185**, 510, abst. J. C. S. 1908, **94**, i, 555

1 Compt. rend. 1904, **138**, 1665, abst. J. C. S. 1904, **86**, i, 751

2 J. C. S. 1904, **85**, 1193, abst. Jahr. Chem. 1904, **57**, 1715

3 U. S. P. 1313661, abst. C. A. 1919, **13**, 2683 U. S. P. 1324140, abst. C. A. 1920, **14**, 415, Chem. Met. Engrg. 1920, **22**, 616, J. S. C. I. 1920, **39**, 135-A. U. S. P. 1326248, abst. J. S. C. I. 1920, **19**, 174 A, C. A. 1920, **14**, 548

4 Chem. Ztg. 1910, **34**, 220, abst. J. C. S. 1910, **98**, i, 273

5 Ber. 1912, **45**, 3208, 3215, abst. C. A. 1913, **7**, 1170

6 H. Tyer and J. Helm, E. P. 2673, 1855

7 M. Ziegler, U. S. P. 163041, 1875

8 E. Naef and W. Thevenaz, E. P. 4649, 1911, abst. J. S. C. I. 1912, **31**, 150.

9 U. S. P. 1169316, 1916, D. R. P. 287796, 1914, abst. J. S. C. I. 1916, **35**, 198, 329

10 Ludy & Co., E. P. 4359, 1908, abst. J. S. C. I. 1908, **27**, 470

11 A. Haller and E. Bauer, Compt. rend. 1906, **142**, 677, abst. J. S. C. I. 1906, **25**, 390 See also Compt. rend. 1904, **138**, 1139, 1905, **140**, 127, 1626, 1909, **148**, 1643, abst. C. A. 1909, **3**, 1161, 2675

12 See J. Ferns and A. Lapworth, J. C. S. 1912, **101**, 278, abst. C. A. 1912, **6**, 1742.

dissolving and colloid functions, imperceptibly blend from one class into another, and their effect is often attenuated or heightened by the application of pressure, vacuum, or heat. Therefore in this historical skeleton synopsis, perhaps an enumeration of some of the more important of these bodies which have been proposed from time to time, arranged according to a chemical classification as far as possible, will best serve the purpose of calling attention to the extreme importance of this chapter of cellulose ester technology.* Details are given in Volume II.

Of the aliphatic alkyl esters, neutral oxalic¹ and oxamic esters (methyl, ethyl, propyl),² methyl, ethyl, propyl and butyl palmitates, stearates and oleates,³ chlorinated stearic and palmitic acids,⁴ isobutyldichloroacetyl tartrate,⁵ butyl and amyl tartrates,⁶ nitroisobutylglycerol trinitrate, nitroglycerol,⁷ glyceryl malate,⁸ methyl and ethyl sebacate,⁹ methyl, ethyl, propyl,

1. R. Scheuble, Aust. P. 42260, 1910. See also C. Lowig, J. prakt. Chem. 1860, **79**, 455; abst. Jahr. Chem. 1861, **14**, 598; E. Du villier and A. Buisine, Ann. Chim. Phys. 1881, **23**, 289; W. Seng and A. Steyrey, Monatsh. 1896, **17**, 614; A. Cahours and E. Demarcay, Bull. Soc. Chim. 1877, **27**, 510. E. Schatzky, Jahr. Chem. 1886, **39**, 1312. The dimethyl, diethyl, or β -methyl esters of adipic acid have been proposed by F. Bayer & Co. as an adhesive for cellulose derivatives, D. R. P. 317412, 1917; abst. J. S. C. I. 1920, **39**, 361-A; Chem. Zentr. 1920, **91**, II, 341. H. Clarke (U. S. P. 1309981, 1919) has recently described dibutyl oxalate and diamyl oxalate as a cellulose nitrate solvent, either alone or preferably in combination with amyl acetate, butyl acetate, ethyl propionate, ethyl butyrate, diethylsulfone, or monochloronaphthalene, the latter being used as high-boiling, auxiliary softeners.
2. E. Zühl, F. P. 309963, 1901; abst. J. S. C. I. 1902, **21**, 65; Mon. Sci. 1902, **58**, 171. For properties of isobutenyl acetate see Z. Pogorshelski, J. Russ. Phys. Chem. Soc. 1904, **36**, 1129; abst. Chem. Centr. 1905, **76**, I, 667.
3. Soc. anon. nouvelle "L'Oyonnithe," F. P. 387179, 1908; abst. J. S. C. I. 1908, **27**, 828; C. A. 1909, **3**, 1819; Mon. Sci. 1909, **70**, 14. For the use of cetyl palmitate see J. Lewin, E. P. 2149, 1880; R. Sjoberg, E. P. 2302, 1881; abst. Dingl. Poly. 1882, **246**, 184; Chem. Ind. 1882, **5**, 120; Jahr. Chem. 1882, **35**, 1411; Bull. Soc. Chim. 1882, **38**, 601; Ber. 1882, **15**, 266; Wag. Jahr. 1882, **28**, 404; Chem. Tech. Rep. 1883, **22**, I, 153; Proc. U. S. Nav. Inst. 1883, **9**, 751; Chem. News, 1885, **52**, 101. E. Preiswerk, E. P. 123685, 1918; U. S. P. 1318461, 1919; abst. J. S. C. I. 1919, **38**, 268-A; 1920, **39**, 135-A.
4. J. Aylsworth, U. S. P. 962877, 1910; abst. Mon. Sci. 1911, **75**, 11.
5. T. Patterson and A. Davidson, J. C. S. 1912, **101**, 378.
6. T. Tesse, U. S. P. Appl. Ser. No. 71201, 123640, 214525, 221089, 241686 (1916-18).
7. H. Luttke, E. P. 24955, 1902; F. P. 325548, 1902; abst. J. S. C. I. 1903, **22**, 318, 760. See also F. Matthews, E. P. 16278, 1911, for the use of cinnamene and styrolgne.
8. General Electric Co., E. P. 24059, 24060, 24254, 24255, 1912; 22544, 1913.
9. J. Goldsmith and British Xylonite Co., E. P. 15914, 1894; D. R. P. 139738, 1904.

butyl and amyl carbonates,¹ and carbamates,² triethyl citrate,³ are examples. Of the bodies analogous or related to glycerol, may be mentioned mono-, di- and tri-acetin,⁴ diphenylglyceryl ether, phenyl glycide, dicresylglyceryl ether,⁵ tetraethylglycol,⁶ and diglycerol.⁷

As representatives of the group of alkyl aromatic esters, would be included methyl, ethyl, propyl, butyl and amyl carbanilates,⁸ glycol benzoate, salicylate, *o*-toluate, *o*-chlorbenzoate, *p*-nitrobenzoate, phenylacetate, hydrotropate, phenylethylacetate, phenyldiethylacetate, hydrocinnamate, and phenyldiethylcarbinacetate;⁹ chlorethyl-, bromethyl-, and chloroxypropylcinnamates;¹⁰ isopropyl-*p*-amino- and isopropyl-*p*-nitrobenzoate;¹¹ vetivenol acetate,¹² methyl, ethyl, propyl, amyl, phenyl, glyceryl, benzyl acetylsalicylates;¹³ benzyl acetate¹⁴ and benzoate.¹⁵ The

1. J. Stevens and F. Axtell, U. S. P. 610728, 1898.
2. J. Stevens, U. S. P. 568106, 1896.
3. J. Stevens, U. S. P. 568105, 1896.
4. W. Plinatus, E. P. 25449, 1911. J. Grolea and J. Weyler, E. P. 131678, 1918; abst. C. A. 1920, **14**, 286. For the separation and determination of eugenol, triacetin and benzyl alcohol, see H. Perperot, *Ann. Chim. anal. chim. appl.* 1919, I, 112; abst. C. A. 1919, **13**, 1686. See Spec. D. 11, 1917, R. A. F. (British).
5. H. Danzer, E. P. 13239, 1912, abst. J. S. C. I. 1912, **31**, 1120.
6. Farbenfabr. vorm. F. Bayer & Co., Swiss P. 58410, abst. Chem. Ztg. 1913, **37**, 228.
7. C. Claessen, D. R. P. 198711, 1907, E. P. 9572, 1908, abst. *Zts. ang. Chem.* 1908, **21**, 326, *Chem. Zentr.* 1908, **73**, I, 2068, *Chem. Ztg. Rep.* 1908, **32**, 307, *Chem. Ind.* 1908, **31**, 377; *Wag. Jahr.* 1908, **54**, II, 418.
8. J. Stevens and F. Axtell, U. S. P. 568104, 1896.
9. Farbenfabr. vorm. F. Bayer & Co., E. P. 8012, 1911. D. R. P. 307125; (abst. *Chem. Zentr.* 1920, **91**, II, 505) covers the use of β -naphthol amyl ether. For data on amyl benzoate, see L. Toost, *Compt. rend.* 1879, **89**, 351.
10. Farbenfabr. vorm. F. Bayer & Co., E. P. 28247, 1910.
11. Farbenfabr. vorm. F. Bayer & Co., E. P. 4321, 1909.
12. F. Semmler, F. Risse and F. Schröter, *Ber.* 1912, **45**, 2348, 2531.
13. Soc. Chim. des Usines du Rhone, E. P. 14699, 1902; 17985, 1911. F. P. 483622, 1917; abst. C. A. 1918, **12**, 910.
14. E. Seelig, D. R. P. 41508, 1887. See also F. Klever, F. P. 462438, 462439, 1913; E. P. 20504, 20505, 1913; Belg. P. 260151, 260152, 1913; abst. *Chem. Ztg.* 1913, **37**, 1250, 1442, 1601.
15. W. Lindsay and The Celluloid Co., U. S. P. 961360, 1910; E. P. 13692, 1910; F. P. 416843, 1910; D. R. P. 251372, 1910; abst. C. A. 1910, **4**, 2581; J. S. C. I. 1910, **29**, 875; 1911, **30**, 27; *Chem. Zentr.* 1912, **83**, II, 1248; *Kunst.* 1912, **2**, 393. U. S. P. 1233374, 1917; abst. C. A. 1917, **11**, 2612. U. S. P. 1292819, 1919; abst. J. S. C. I. 1919, **38**, 282A. For the physiological action of benzyl benzoate see J. Boice, *N. Y. Medical J.* 1919, **110**, No. 24. Fremy-Kraut, *Ann.* 1870, **153**, 129; D. Macht, *J. Pharmacol. and Exp. Ther.* 1916, **9**, 121; 1917, **9**, 287; *July* 1918, No. 6; *Southern Med. J.* 1919, **7**, No. 7; *J. Amer. Med. Assoc.* **73**, 599. D. Macht and Fischer, *J. Pharmacol. and Exp. Ther.* 1917, **10**, 95; J. Litzenberg, *J. Amer. Med. Assoc.*

phthalic acid esters have been employed considerably for the production of specific effects, especially, and include ethyl, diethyl,¹ glyceryl,² diphenyl,³ and diamyl phthalates,⁴ diethyl isophthalate and ethyl cinnamate,⁵ and the ethyl esters of phthalonic, phthalamic and phthalanilic acids.⁶

The aryl aliphatic and aromatic esters comprize an extensive and valuable group, among which may be cited phenyl benzoate⁷ and salicylate (salol),⁸ ethyl trichlorisopropyl, and ethyl trichlorisobutyl acetylsalicylates,⁹ benzyl propionate,¹⁰ menthyl acetate,¹¹ naphthyl acetate,¹² propionate,¹³ benzoate (benzonaphthol);¹⁴ ben-

- 73, 601. *Medical Record*, **93**, 1005. See also W. Lindsay, U. S. P. 1027619, 1912; E. P. 20978, 1911, F. P. 432264 and additions thereto dated July 7, 15, and Sept. 13, 1911, Belg. P. 241250. U. S. P. 1031616, 1912; abst. J. S. C. I. 1912, **31**, 770; C. A. 1912, **6**, 2687. E. P. 18193, 1909, abst. J. S. C. I. 1910, **29**, 575. E. P. 11354, 1909, abst. J. S. C. I. 1910, **29**, 752; E. P. 13100, 1910, abst. J. S. C. I. 1911, **30**, 533. F. P. 408370, 1910, abst. J. S. C. I. 1910, **29**, 624. First addn. No. 12169, dated April 13, 1910, to F. P. 408370 and second addn. dated June 11, 1910, to F. P. 408370, abst. J. S. C. I. 1910, **29**, 1371. Aust. P. 4642-10, 1909. For its use in connection with cellulose acetate see H. Dreyfus, U. S. P. 961360, 1910. F. P. 416843, 1910, abst. J. S. C. I. 1910, **29**, 875. Celluloid Co., D. R. P. 236056, 1910, abst. C. A. 1913, **7**, 3840. E. P. 13692, 1910, abst. J. S. C. I. 1911, **30**, 279. See also G. Ferguson, U. S. P. 1292743, 1292741, 1919, abst. J. S. C. I. 1919, **38**, 313-A. A.-G. Anilinfabr., D. R. P. 268626, Aust. P. 66721, F. P. 159922, E. P. 17523, 1913.
1. L. Lilienfeld, E. P. 592, 1907, Aust. P. 47237, 47238. A. Nobel, E. P. 15914, 1894. A. Hesse, D. R. P. 251237, Addn. to D. R. P. 227667, 1911.
2. E. Dawson and the General Electric Co., U. S. P. 1111944, abst. C. A. 1915, **9**, 1978; E. P. 9985, 1913, abst. C. A. 1914, **8**, 3507, Kunst. 1914, **4**, 117.
3. Farb- u. Meissner, Lucius & Brunning, D. R. P. 127816, abst. Jahr. Chem. 1902, **55**, 1056, Wag. Jahr. 1902, **48**, 11, 594, Mon. Sci. 1902, **53**, 78, Chem. Centr. 1902, **73**, I, 288. D. R. P. 122272, 1899.
4. C. Lundholm, and Nobel's Expl. Co., Ltd., India P. Appl. 406, 1902.
5. Soc. Nauton Freres & de Marsac and T. Tesse, E. P. 126980, 1916, abst. C. A. 1919, **13**, 2460. See also E. P. 124763.
6. E. Zühl, F. P. 308372 and addition dated April 15, 1901; abst. J. S. C. I. 1902, **21**, 65; Mon. Sci. 1902, **58**, 159.
7. H. Matheson, U. S. P. 1161063, 1915, abst. J. S. C. I. 1916, **35**, 40. E. Ohlsson, U. S. P. Appl. Ser. No. 378821, May 4, 1920.
8. Chem. and Drug. 1914, **85**, 313, abst. J. S. C. I. 1914, **33**, 886.
9. R. Wolfenstein, E. P. 27562, 1911, abst. C. A. 1913, **7**, 1787.
10. F. Klever, Belg. P. 260151, 260152, 1913.
11. T. Patterson and F. Taylor, J. C. S. 1905, **87**, 33; abst. Chem. Centr. 1905, **76**, I, 819.
12. Zühl & Eisemann, D. R. P. 118052, 119636, Aust. P. 6545, 1902; E. Zühl, U. S. P. 700885, 1902; E. P. 11751, 1900, 8072, 1901, 23445, 1902, F. P. 301703, 325585, 1903; abst. J. S. C. I. 1901, **20**, 741, 870, 1903, **22**, 315; 757; Mon. Sci. 1901, **57**, 165, 216; 1902, **58**, 21; Chem. Centr. 1901, **72**, I,

zylidene diacetate (3-methyl-5-phenyl-4,6-dicarboethenyl- α_2 -keto-R-hexene),¹ and the monochlorides of benzene, aniline and nitronaphthalene, and naphthalene trichloride;³ acidyl derivatives of secondary aliphatic aromatic amines, acetyl derivatives of halogenized aromatic amines, chloracetanilid, methylaniline, methylnaphthylamine,⁴ menthol, borneol and santalol methoxyacetates, ethoxyacetates, and chlor-substituted acids, methoxy-, ethoxy-, acetylborneol, acetylmenthol, and acetylsantalol.⁵ These are indicative of the range and complexity of this group.

The use of naphthalene with nitrocellulose has been patented by J. Stevens,⁶ J. Chaubet,⁷ the Soc. gen. pour la fabrication des Matieres Plastiques,⁸ and by L. Arbezcarne in conjunction with rosin.⁹ Naphthol,¹⁰ naphthalene and camphor,¹¹ di-, tri-

551, *Jahr Chem* 1901, **54**, 900, *Wag. Jahr* 1901, **47**, 11, 608, *Zts. ang. Chem.* 1901, **14**, 296, 448.

13. E. Zühl, E. P. 17948, 1900, U. S. P. 700884, 1902. Includes also the use of diphenyl carbonate, dinaphthyl carbonate, resorcin diacetate, chloronaphthylacetate and nitronaphthylacetate.

14. G. Blumberg, U. S. P. 1251970, abstr. C. A. 1918, **12**, 703. J. Stevens, U. S. P. 572134, 1896.

15. C. Claessen, D. R. P. 172066, 172067, 174259, F. P. 363090, 1906; Aust. P. 26335, 1906, abstr. C. A. 1907, **1**, 1198, J. S. C. I. 1906, **25**, 865, *Mon. Sci.* 1908, **68**, 15, 46, 1911, **74**, 63, *Chem. Centr.* 1906, **77**, 11, 736, 1631, *Chem. Ztg. Rep.* 1906, **30**, 260, 346, *Jahr. Chem.* 1905 8, 11, 992, *Wag. Jahr.* 1906, **52**, 11, 526, 527, *Zts. ang. Chem.* 1907, **20**, 115. D. R. P. 174259 also describes the use of ethylidenediacetoacetate.

16. C. Claessen and Badische Anilin- u. Sodafabrik, D. R. P. 173020, 1904, abstr. C. A. 1907, **1**, 672, *Chem. Centr.* 1906, **75**, 11, 990, *Jahr. Chem.* 1905 8, 11, 991, *Wag. Jahr.* 1906, **52**, 527.

17. E. Zühl, E. P. 10213, 1901, abstr. J. S. C. I. 1901, **20**, 831, F. P. 310942, 1901, abstr. J. S. C. I. 1902, **21**, 65, *Mon. Sci.* 1902, **58**, 174.

18. *Chem. Fabr. vorm. Weiler-Ter-Meer*, E. P. 15435, 1904, 16271, 1906, F. P. 341556, 1904, 377671, 1906, Belg. P. 194836, 1906, Can. P. 103036, abstr. J. S. C. I. 1904, **23**, 880, 1905, **24**, 686, 1907, **26**, 989, 1064, *Mon. Sci.* 1908, **68**, 145, C. A. 1907, **1**, 2831. See also E. P. 12863, 22662, 1901, 2817, 1906.

19. *Farbenfabr. vorm. F. Bayer & Co.*, F. P. 367057, 1906. For the preparation of terphenyl propionate, diacetate, acetate, etc., see J. Houben, D. R. P. 162863, abstr. *Chem. Centr.* 1905, **76**, 11, 1060, *Wag. Jahr.* 1905, **51**, 11, 124.

20. U. S. P. 543197, 1895.

21. E. P. 13287, 20239, 1899, abstr. J. S. C. I. 1900, **19**, 552.

22. U. S. P. 543197, F. P. 292803, D. R. P. 117542, abstr. *Chem. Centr.* 1901, **72**, 1, 352, *Jahr. Chem.* 1901, **54**, 900, *Wag. Jahr.* 1901, **47**, 11, 609, *Graph. Beob.* **9**, 219, *Amer. Apoth. Ztg.* **21**, 31, *Pharm. Centralh.* **41**, 317.

23. F. P. 372512, 1906, abstr. J. S. C. I. 1907, **26**, 634.

24. J. Stevens, U. S. P. 622727, 1899.

25. *Düsseldorfer Celluloidfabrik*, G. m. b. H., E. P. 17069, 1912; abstr. *Kunst.* 1914, **4**, 155; J. S. C. I. 1912, **31**, xv. F. P. 446270, 1912.

and tetra-methylnaphthalenes,¹ phenanthrene,² and the crystalline chlorides of toluene, benzylnitrochlorides, chlorides, bromides, nitrochlorides and nitrobromides of benzene, toluene, xylene and naphthalene, have all been advocated as useful adjuncts with nitrocellulose.³ Stockhausen has described pyroxylin plastics containing ethyl lactate and salicylate.⁴

As combined solvents and flammability-reducing bodies, phenyl, cresyl, and naphthyl carbonates,⁵ phosphates,⁶ and thiophosphates;⁷ methyl, ethyl, phenyl, cresyl or naphthyl anilid phosphoric esters (diphenylphosphoric-alkyl or aryl ester or anilid, phenylphosphoric di-alkyl or aryl ester or anilid);⁸ phenyl

1. O. Silberrad, E. P. 19381, 1912, abst. J. S. C. I. 1913, **32**, 843. Belg. P. 246526, 1912.

2. G. Spica, E. P. 14004, 1914. E. P. 126013, 1916; abst. C. A. 1919, **13**, 2280. See also Atti Reale Inst. Venet. Scienze, Lettere ed Arti, 1911-12, **71**, 782, Zts. Schiess. Spreng. 1912, **7**, 129.

3. J. Stevens, U. S. P. 583516, 1897.

4. D. R. P. 281262, 1910; F. P. 428468, 1911, Aust. P. 8192, 1911; abst. Kunst. 1912, **2**, 460; 1915, **5**, 69.

5. Zuhl & Eisemann, D. R. P. 139589; abst. Wag. Jahr. 1903, **49**, II, 569; Jahr. Chem. 1903, **56**, 1019, Chem. Centr. 1903, **74**, I, 749. D. R. P. 142971, abst. Wag. Jahr. 1903, **49**, II, 569. E. Zuhl, U. S. P. 700884, 1902.

6. E. Zuhl, U. S. P. 700885, 1902, F. P. 309962, 1901; abst. J. S. C. I. 1902, **21**, 65. Zuhl & Eisemann, D. R. P. 128120; abst. Jahr. Chem. 1902, **55**, 1057; Mon. Sci. 1902, **58**, 163, Pharm. Centralh. 1902, **43**, 115. Aust. P. 9957. D. R. P. 173014; abst. Wag. Jahr. 1906, **52**, II, 527. D. R. P. 173796, 1905; abst. Mon. Sci. 1908, **68**, 160, Jahr. Chem. 1905-8, II, 993; Chem. Centr. 1906, **77**, II, 990. Aust. P. 13838, 1903. D. R. P. 142971, 1902, abst. Chem. Centr. 1903, **74**, II, 171. Akt. Ges. f. Anilin-Fabrikation, E. P. 1154, 1912. W. Merckens and H. Manissadjian, F. P. 413657, 1910. W. Lindsay, F. P. 415517, 1910. Cf. Spec. D. 12, 1917; R. A. F. (British). The Organic Salt & Acid Co. of Long Island City, N. Y., under the name of Orsacid, prepare a triphenyl phosphate of high purity.

7. E. Zuhl, U. S. P. 733110; E. P. 4383, 1902; 23445, 1902; F. P. 309962, 1901, and addition dated Feb. 22, 1902; Russ. P. 8893, 1904; abst. J. S. C. I. 1902, **21**, 65, 719, 1467; 1903, **22**, 922; 1905, **24**, 315; Mon. Sci. 1902, **58**, 171, 1903, **59**, 186. Zuhl & Eisemann, D. R. P. 104164, 142832, abst. Chem. Centr. 1903, **74**, I, 860; II, 171; Jahr. Chem. 1903, **56**, 1019; Wag. Jahr. 1903, **49**, II, 569.

8. Zuhl & Eisemann, D. R. P. 144648, 1902; abst. Mon. Sci. 1904, **60**, 93; Chem. Centr. 1903, **74**, II, 1041; Wag. Jahr. 1903, **49**, II, 569. E. P. 23445, 1902; abst. J. S. C. I. 1903, **22**, 315. D. R. P. 128956; abst. Jahr. Chem. 1902, **55**, 1057, Chem. Centr. 1902, **73**, I, 612; covers the use of mono- or polyhalogen substituted aromatic hydrocarbons. D. R. P. 128119, 1901; abst. Chem. Centr. 1902, **73**, I, 387; Mon. Sci. 1902, **51**, 163; Jahr. Chem. 1901, **55**, 1057; describes the use of methyl, ethyl, amyl and isobutyl oxalilate. In this connection see also H. Clarke and the Eastman Kodak Co., cellulose esters containing dialkyl oxalates in which each of the alkyl groups contains four or five carbon atoms, U. S. P. 1309980, 1309981, 1919; abst. J. S. C. I. 1919, **38**, 768-A.

formate, propionate, carbonate, tartrate, citrate, or malate¹ have been used to a considerable extent, especially the phenyl phosphates. The addition of cellulose acetate with the nitro-celluloses, as in the methods of E. Zühl,² R. Muller,³ E. Berl and W. Smith,⁴ L. Lederer,⁵ L. Clement and C. Riviere,⁶ and B. Oddo,⁷ and the nitrobenzoyl nitrates of C. Cross, E. Bevan and R. Jenks,⁸ have also been used for decreasing the inflammability. The methyl, ethyl and amyl esters of diphenyl-, diacetyl-, and dinaphthyl-phosphoric acid have also been described.⁹ Decreased inflammability and solvent power is also obtained when certain resinous products are incorporated with pyroxylin, as colophony,¹⁰ shellac, dammar, mastic, acaroid,¹¹ rosin soaps,¹² kauri (copal),¹³ coumarone and indene,¹⁴ *p*-cumarone and *p*-indene,¹⁵

1. E. Zühl, U. S. P. 700884, 1902; E. P. 17948, 1900; abst. J. S. C. I. 1901, **20**, 926, 1902, **21**, 870.

2. U. S. P. 729990, 1903; abst. J. S. C. I. 1903, **22**, 817. D. R. P. 162239, abst. Jahr. Chem. 1905-8, II, 993; Chem. Centr. 1905, **76**, II, 1000.

3. R. Muller and Deutsche Celluloid Fabrik, E. P. 5773, 1914, abst. C. A. 1915, **9**, 2292. See also Akt.-Ges. f. Anilin-Fabrikation, F. P. 449253, 1912, cf. E. P. 3645, 1907, F. P. 368768, 1906. See Zts. ang. Chem. 1901, **14**, 483.

4. Ber. 1907, **40**, 903; 1908, **41**, 1837, J. S. C. I. 1908, **27**, 534, 538, abst. C. A. 1907, **1**, 2179, J. C. S. 1907, **92**, i, 289, 1908, **94**, i, 505, J. S. C. I. 1907, **26**, 273, Bull. Soc. Chim. 1909, **6**, 499, Chem. Zentr. 1907, **78**, I, 1108, 1908, **79**, II, 299, 686, Chem. Ztg. Rep. 1907, **31**, 257, Jahr. Chem. 1905-8, II, 977, 982, 985, Zts. ang. Chem. 1908, **21**, 1185, 2427. See also H. Ost, Zts. ang. Chem. 1906, **19**, 993, abst. Chem. Centr. 1906, **77**, II, 672. C. Cross, E. Bevan and R. Jenks, Chem. News, 1901, **84**, 61.

5. D. R. P. 179947, 1905, abst. Chem. Zentr. 1907, **78**, I, 433. D. R. P. 200149, 1906, abst. Chem. Zentr. 1908, **79**, II, 551. E. P. 19107, 1906; describes the use of nitroacetyl- and nitrobutyl-cellulose.

6. U. S. P. 1168164, 1916; abst. J. S. C. I. 1916, **35**, 251. See F. P. 449253, 1912; abst. J. S. C. I. 1913, **32**, 482.

7. Gaz. chim. ital. 1919, **49**, ii, 140, abst. J. S. C. I. 1920, **39**, 12-A.

8. Ber. 1901, **34**, 2496; abst. J. S. C. I. 1901, **20**, 1133, Chem. News, 1901, **84**, 61.

9. Zühl & Eisemann, Aust. P. 13838, addition to Aust. P. 9557. The F. Bayer Co. has recently (D. R. P. 307125, 1917; abst. J. S. C. I. 1920, **39**, 400-A) patented the use of β -naphthol amyl ether in connection with acetyl-, nitro-, ethyl-, propyl- and benzyl cellulose.

10. P. Jacquemin and R. Heraud, F. P. 424820, abst. Kunst. 1911, **1**, 316; Mon. Sci. 1913, **78**, 46.

11. Zühl & Eisemann, D. R. P. 177778; abst. C. A. 1907, **1**, 1351; J. S. C. I. 1907, **26**, 340; Zts. ang. Chem. 1907, **20**, 369; Chem. Zentr. 1907, **78**, I, 143, Jahr. Chem. 1905-8, II, 993; Chem. Ztg. Rep. 1906, **30**, 439; Wag. Jahr. 1907, **63**, II, 562; Mon. Sci. 1909, **70**, 90.

12. F. Stracke, D. R. P. 102962, 1899; abst. Wag. Jahr. 1899, **45**, 1899.

13. J. McClelland, U. S. P. 366231, 1887; abst. J. A. C. S. 1887, **9**, 158.

14. F. Lehmann, F. P. 469925, 1914. In this connection see T. Schopper, Gummi-Ztg. 1915, **29**, 1250; Zts. ang. Chem. 1915, **28**, II, 644; abst. J. S. C. I.

and 'resin and castor oil.¹ H. Franquet,² H. Ensminger,³ Soc. anon. l'Oyonnaxienne,⁴ and Soc. Industrielle de 'Celluloid,⁵ employ casein, dextrin and starch.

Of the higher boiling ketones, methylnaphthyl, dinaphthyl, methoxylnaphthyl and dioxynaphthyl ketones,⁶ methylketobutanol,⁷ and dioxydiphenyldimethylmethane, dioxydiphenylethylmethylmethane, dioxydiphenyldiethylmethane and dioxyditolyldimethylmethane⁸ are illustrative. Aldols⁹ as acetaldol in the hands of H. Hibbert¹⁰ and W. Weedon,¹¹ apparently are destined to be used in large quantities as nitro cotton adjuncts. Other

1916, **35**, 356, who describes the use of dimethylamino- β -methyl-coumarin

15. J. McCoy and Westinghouse Electric and Mfg Co., U. S. P. 1245363, 1917, abst. J. S. C. I. 1918, **37**, 14-A

1. C. Gillet, F. P. 352853, 1905, abst. J. S. C. I. 1905, **24**, 984; C. A. 1907, **1**, 1197. F. P. 382270, 382350, abst. J. S. C. I. 1908, **27**, 178, 244.

2. F. P. 312817, 1901, abst. J. S. C. I. 1902, **21**, 134. D. R. P. 139905, 1902, abst. Mon. Sci. 1904, **60**, 92, Jahr. Chem. 1903, **56**, 1019.

3. E. P. 3045, 1903, abst. J. S. C. I. 1904, **23**, 202.

4. F. P. 331819, 1903; abst. J. S. C. I. 1903, **22**, 1206; Mon. Sci. 1904, **60**, 69.

5. F. P. 319542, 1902; 407846, 1909; D. R. P. 141310, 1902, abst. Chem. Centr. 1903, **74**, I, 1164, Jahr. Chem. 1903, **56**, 1020, Zts. ang. Chem. 1904, **16**, 425, Wag. Jahr. 1903, **49**, II, 509. D. R. P. 221081, abst. C. A. 1910, **4**, 2732, Chem. Zentr. 1910, **81**, I, 1662, Jahr. Chem. 1910, **63**, II, 428, Wag. Jahr. 1910, **56**, II, 589.

6. E. Zühl, E. P. 20733, 1900, abst. J. S. C. I. 1901, **20**, 273, F. P. 305481, 1900, abst. Mon. Sci. 1902, **58**, 21; D. R. P. 118052, 1900, abst. Chem. Centr. 1901, **72**, I, 551, Zühl & Eisemann, D. R. P. 122166, abst. Chem. Centr. 1901, **72**, II, 251, J. S. C. I. 1901, **20**, 926, Mon. Sci. 1901, **57**, 292. See also R. Ortman, E. P. 5280, 1904. H. Blackmore, U. S. P. 830044, 1906.

7. Farbenfabr. vorm. F. Bayer & Co., E. P. 19087, 1909.

8. W. Beatty, U. S. P. 1158960, 1158961, 1915, F. P. 447645, abst. J. S. C. I. 1912, **31**, 283, 1915, **34**, 1205. U. S. P. 1188356, 1916, abst. J. S. C. I. 1916, **35**, 923; C. A. 1916, **10**, 2146. E. P. 18822, 18824, 1912; 18499, 1913.

9. Farbenfabr. vorm. F. Bayer & Co., E. P. 940, 1913.

10. H. Hibbert and E. I. du Pont de Nemours Powder Co., U. S. P. 994841, 994842, 1911. U. S. P. 1158217, 1915, abst. C. A. 1915, **9**, 3363. U. S. P. 1164647, 1915, abst. J. S. C. I. 1916, **35**, 198, U. S. P. 1213367, 1917, abst. C. A. 1917, **11**, 888. U. S. P. 1313661, 1919, abst. J. S. C. I. 1919, **38**, 794 A. E. P. 4009, 1911, 22621, 22622, 22623, 22626, 22964, 1912; 5408, 1914, abst. J. S. C. I. 1911, **30**, 836, 1914, **33**, 161, 1913, **32**, 1105; 1914, **33**, 984; C. A. 1914, **8**, 992, 1010, 984; Kunst. 1914, **4**, 155. F. P. 449604, 449605, 449606, 1912, abst. J. S. C. I. 1913, **32**, 507, 508; C. A. 1913, **7**, 2683, Mon. Sci. 1914, **81**, 5, Chem. Ztg. 1913, **37**, 228. D. R. P. 292951, 1916; abst. Chem. Zentr. 1916, **87**, II, 246. Swiss P. 63136, 63137, 64932, 1912; abst. C. A. 1914, **8**, 3490. Belg. P. 250118, 252722, 1913, abst. Chem. Ztg. 1913, **37**, 76. Aust. P. 72493, 1916; abst. C. A. 1917, **11**, 1041.

11. W. Weedon and E. I. du Pont de Nemours Co., U. S. P. 1082573, 1913; F. P. 449607, 1912, E. P. 22622, 1912; abst. C. A. 1914, **8**, 822; J. S. C. I. 1913, **32**, 509, 1105; 1914, **33**, 132, 822.

aldehyde condensation products,¹ paraldehyde,² chloral³ alone and with amyl lactate,⁴ mixed aldehydes,⁵ chloral hydrate,⁶ are examples of this class of bodies which have passed patent acceptance. H. Dreyfus has patented anisol, phenetol, methyl naphthyl and ethyl naphthyl ethers, veratrol, pyrocatechol diethyl ether, methyl benzyl ether⁷ eugenol and isoeugenol, benzyl ethers,⁸ quinones,⁹ cresylphenyl, naphthylphenyl, and guaiacotphenyl ethers;¹⁰ methylenethylenic, ethyleneglycolic, methylene-glycerol, acetoneglycerol, benzylidene glycerol, formalerythritic, and diacetonearabitic ethers,¹¹ have all alleged peculiarly cellulose ester malaxating properties.

The chlorhydrins, in some instances, exhibit a tendency to decomposition, and therefore their use has been limited. Among bodies of this nature which have been brought forward, may be cited acetdichlorhydrin, diacetochlorhydrin, and monoacetochlorhydrin,¹² benzicins (glyceryl benzoates), glyceryl phthalates and succinates, pulegone and thujone. Mononitromonochlorhydrin¹³ methyl and ethyl adipate, pimelate, suberate, azelaate, and sebacate have been described by J. Goldsmith.¹⁴ C. Boehringer

1 N. Grunstein, E. P. 101636, 1916, abst. C. A. 1917, **11**, 195.

2 Chem. and Drug. 1914, **85**, 313, abst. J. S. C. I. 1914, **33**, 886.

3 S. Gartner, E. P. 14955, 1904, abst. J. S. C. I. 1905, **24**, 689.

4 C. Ellis, U. S. P. 909490, 1911, abst. Mon. Sci. 1912, **77**, 163.

5 R. Eisenmann, D. R. P. 195312, 195313, 192606, abst. Wag. Jahr. 1908, **54**, 96. A. King and F. Mason (U. S. P. 1312186, abst. C. A. 1919, **13**, 2536, E. P. 101428, 1916, abst. J. S. C. I. 1916, **35**, 1131, 1919, **38**, 696-A) describe the preparation of acetals.

6 L. Lederer, U. S. P. 1195040, 1916, abst. C. A. 1916, **10**, 2637. E. P. 19330, 1905; 9537, 1907, abst. J. S. C. I. 1908, **27**, 589. F. P. 377010, 1907, abst. J. S. C. I. 1907, **26**, 1027. D. R. P. 220228, abst. Jahr. Chem. 1910, **63**, II, 428, C. A. 1910, **4**, 2203.

7 H. Dreyfus, U. S. P. 1181859, 1181860, 1916.

8 Boehringer & Sons, U. S. P. 487167, 487205, abst. J. A. C. S. 1892, **14**, 390, 391.

9 C. Torley, E. P. 9450, 9451, 1913, abst. J. S. C. I. 1914, **33**, 347, 569.

10 L. Ostermann, U. S. P. 1099761, 1914, abst. C. A. 1914, **8**, 2779.

11 Boehringer & Sons, U. S. P. 996191, 1911, D. R. P. 214962, abst. Rev. chim. ind. 1910, **21**, 156; Zts. Chem. Ind. Koll. 1910, **6**, 61.

12 J. Goldsmith and the British Xylonite Co., E. P. 13131, 1900, abst. J. S. C. I. 1901, **20**, 741, Mon. Sci. 1902, **58**, 163. F. P. 307242, 1901, abst. Mon. Sci. 1902, **58**, 157. D. R. P. 125315, 1900, abst. Chem. Centr. 1901, **72**, II, 1192, Mon. Sci. 1902, **58**, 78, Jahr. Chem. 1901, **54**, 900, Wag. Jahr. 1901, **47**, II, 609.

13 Westfahlsch. Anhaltische Sprengstoff Akt.-Ges., F. P. 352750, 1905; 370132, 1906. See W. Lindsay, U. S. P. 1027617, 1027618, 1911.

14 E. P. 15914, 1894; D. R. P. 139738; abst. Chem. Centr. 1903, **74**,

& Sohs¹ advocate the use of cyclic ethers from aldehydes and ketones coupled with polybasic alcohols.

The various nitrogen-containing compounds have been used extensively as adjuncts of nitrocellulose, both in the explosives and plastic arts. Among the nitro compounds, may be cited nitrobenzene, nitrotoluene, nitrocymene, nitronaphthalin;² dinitrobenzene,³ trinitroanisol, trinitrophenetol;⁴ dinitrotoluene with camphor;⁵ *p*-nitrotoluene and camphor;⁶ dinitroxyline with acetanilid;⁷ nitronaphthalin,⁸ and the ethers of nitrophenols.⁹ E. Ritsert has received patent protection for a series of alkyl esters of 3:4-diamidobenzoic acid (ethyl-*m*-nitro-*p*-amidobenzoate, 3-nitro-4-acetamidobenzoic acid, methyl-3:4-diamidobenzoic acid) which, in combination, produce useful plastic effects.¹⁰ The Badische Aniline & Soda Fabrik¹¹ have described a class of polychloramidines (*o*-toluylenemethenylamidine, ethylethenyltrichloramidine, methylethenyltrichloramidine) which with nitrocellulose

I, 749, Mon. Sci. 1904, **60**, 92 E. P. 22662, 1901; abst. J. S. C. I. 1902, **21**, 1293. See also E. P. 2817, 16271, 1906.

1. D. R. P. 214962, abst. Wag. Jahr. 1909, **55**, II, 554; Zts. ang. Chem. 1909, **22**, 2439; Chem. Zentr. 1909, **80**, II, 1607; Chem. Ztg. Rep. 1909, **33**, 597; Chem. Ind. 1909, **32**, 761; Jahr. Chem. 1909, **62**, II, 391.

2. A. Nobel, E. P. 20231, 1893 Nobel's Explosive Co., Swiss P. 65138, 65139, 65549, 65925, 1913, also cover the use of substituted urethanes; naphthyl ethers, phenyl, methylphenyl-, dimethylphenyl, carbamides or similar products. Azobenzene as a stabilizer and to increase the solubility of nitrocellulose in nitroglycerol has been mentioned by C. Girard and P. Iooss, Mon. Sci. 1913, **78**, 677; abst. C. A. 1914, **8**, 1011.

3. G. Trench, E. P. 18472, 1890; abst. J. S. C. I. 1891, **10**, 949; Chem. Centr. 1892, **63**, II, 358; Chem. Ztg. 1892, **16**, 676; Chem. Tech. Rep. 1892, **31**, I, 224; Wag. Jahr. 1892, **38**, 377. A. Geserich, D. R. P. 93228; abst. Zts. ang. Chem. 1897, **10**, 641. Meta-dinitrobenzene has been used under the name of Trivoline as a deterrent in smokeless powder.

4. Hudson Maxim, E. P. 2039, 1910; U. S. P. 974900, 1910; abst. Mon. Sci. 1911, **75**, 107; C. A. 1911, **5**, 786.

5. J. Stevens, U. S. P. 542692, 543108, 1895.

6. J. Stevens, U. S. P. 552209, 1895.

7. J. Stevens, U. S. P. 553270, 1896.

8. Societe Neumann, Marx et Desvaux, F. P. 300672, 1900; abst. Mon. Sci. 1901, **57**, 60.

9. A. Nobel, E. P. 20234, 1893; 15914, 1894; abst. J. S. C. I. 1894, **13**, 921, 1072; 1895, **14**, 814.

10. E. Ritsert, E. P. 16684, 1903; abst. J. S. C. I. 1904, **23**, 726.

11. U. S. P. 892899, 1908; abst. J. S. C. I. 1908, **27**, 828; E. P. 10228-A, 1906; abst. J. S. C. I. 1906, **25**, 866, 1064; F. P. 366106, 1906; abst. J. S. C. I. 1906, **25**, 1001; C. A. 1907, **1**, 2960; D. R. P. 180126; abst. C. A. 1907, **4**, 2203; J. S. C. I. 1907, **26**, 1064; J. C. S. 1907, **92**, i, 973; Zts. ang. Chem. 1907, **20**, 1541; Chem. Zentr. 1907, **78**, I, 1473; Jahr. Chem. 1905-8, II, 991; Chem. Ztg. Rep. 1907, **31**, 77; Wag. Jahr. 1907, **53**, II, 562 Aust. P. 32175. See also D. R. P. 176474.

produce valuable moldable compounds on application of heat.

There has been granted to J. Stevens a series of patents for the use in conjunction with pyroxylin, acetanilid,¹ *m*-dinitroxylylene,² phenylacetamide,³ methylacetanilid (exalgin),⁴ acetxylylid,⁵ diethylsulfonmethylethylmethane (trional), sulfobenzid (diphenylsulfon), diethylsulfondimethylmethane (sulfonal), and sulfocarbaniid (*s*-diphenylthiocarbamide),⁶ tolyldimethylpyrazolon (tolypyrin), antipyrin salicylate (salipyrin), tolpyrin salicylate (tolysal).⁷ Some of these bodies have been employed in comparatively large amounts for the production of special effects.

Acetylmethyl aniline (manol),⁸ *p*-nitroacetoacetanilid,⁹ formanilid and benzanilid,¹⁰ methylacetanilid,¹¹ methyl-, ethylbenzyl-, trichloranilids, tetrachloranilids, pentachloranilids of the Badische Co.,¹² are examples of anilids and co-related bodies which have proven of unusual interest as plastifiers.

A series of patents have issued through the Nobel's Explosives Co., through F. Nathan, W. Rintoul, F. Baker, N. Pictou, D

1. U. S. P. 510617, 1893; 543108, 1895, abst. J. A. C. S. 1894, **16**, 68.

2. U. S. P. 553270, 1896.

3. U. S. P. 510617, 1893; 517987, 1894; abst. J. A. C. S. 1894, **16**, 68.

4. U. S. P. 551456, 1895.

5. U. S. P. 564343, 1896. See also O. Schmidt, U. S. P. 1200886, 1916, abst. C. A. 1916, **10**, 3160, for the use of acetyldichlorhexylamine and *p*-toluenesulfocyclohexylamine with either cellulose nitrate or acetate.

6. U. S. P. 572135, 1896, abst. J. Soc. Dyers Col. 1897, **13**, 53.

7. U. S. P. 572135, 1896; abst. J. Soc. Dyers Col. 1897, **14**, 53.

8. A. Eichengrün, E. P. 27258, 1910, abst. J. S. C. I. 1911, **30**, 1112, C. A. 1912, **6**, 1526.

9. Farbwerke vorm. Meister, Lucius & Brünig, D. R. P. 246382, 1911; abst. C. A. 1912, **6**, 2496; Zts. ang. Chem. 1912, **25**, 1151.

10. Deutsche Celluloid Fabrik, E. P. 12863, 1901, abst. J. S. C. I. 1902, **21**, 494. See also E. P. 16271, 1906. F. P. 312087, 1901; abst. Mon. Sci. 1902, **58**, 104. D. R. P. 80776; abst. Jahr. Chem. 1895, **48**, 1361; Wag. Jahr. 1895, **41**, 1058. D. R. P. 132371, 1901; abst. Mon. Sci. 1902, **58**, 194; Wag. Jahr. 1902, **48**, II, 594; Jahr. Chem. 1902, **55**, 1057. Aust. P. 11376, 1902.

11. J. Schmerber, F. P. 340266, 348618, 1904, abst. J. S. C. I. 1904, **23**, 512, 758.

12. E. P. 8077, 1906; abst. J. S. C. I. 1906, **25**, 608. F. P. 297464, 1900. E. P. 23544, 1912; abst. J. S. C. I. 1912, **31**, xiii. F. P. 363846, 1906, and addition 6292; abst. C. A. 1907, **1**, 2957; J. S. C. I. 1906, **25**, 1064. F. P. 365297, 1906; D. R. P. 180208; abst. Zts. ang. Chem. 1907, **20**, 461, Wag. Jahr. 1907, **53**, II, 562; J. S. C. I. 1907, **26**, 1064; Jahr. Chem. 1905-8, II, 992; Chem. Zentr. 1907, **78**, I, 681, 682, 1474; J. C. S. 1907, **92**, I, 973. D. R. P. 176474, 1905; abst. Chem. Zentr. 1907, **78**, I, 142; Jahr. Chem. 1905-8, II, 992; Mon. Sci. 1909, **70**, 90; C. A. 1907, **1**, 1350; Wag. Jahr. 1906, **52**, II, 527; Zts. ang. Chem. 1907, **20**, 369; Chem. Ztg. Rep. 1906, **30**, 375. D. R. P. Ann. B-86790; abst. Kunst. 1914, **4**, 139. Aust. P. 32175, 1908. Belg. P. 191531, 1906. Swiss P. 59164, 1913; 64710, 1913.

Cross and D. Peacock for a series of bodies, which in comparatively small amounts (usually less than 1% calculated on the nitrocellulose) possess the property of causing gelatinization with nitroglycerol and nitrocotton, and to which have been given the name of gelatinizing accelerators or activators. They include esters of diphenyl, phenylbenzyl, ethylnaphthyl, and phenanthramethyl,¹ urethanes (phenyl, methylphenyl urethane);² phenyl, methylphenyl urea, and methyldiphenyl urea;³ acet-*o*-idide, acet-*p*-anisidide, acet-*b*-naphthalid, ethylacet-*b*-naphthalide and phenylacet-*a*-naphthalid;⁴ ethyl and amyl phthalates;⁵ phenyl urea;⁶ and a series of other bodies⁷ have been detailed in the original patent specifications. The series of F. Bayer & Co.⁸ and B. Beckmann⁹ are analogous. Tzenberg¹⁰ has described as stabilizers, betaine nitrate, chlorate and permanganate, able to fix nitrogen oxides. Glyceryl-, glyceryl-, phenyl-, cresyl-, *p*-toluenesulfonates and cresylsulfethylanilids have been detailed by Meister, Lucius and Ring.¹¹ They have also described as camphor substitutes those ester plastic formation, the methyl-, ethyl-, isobutyl-, nyl-carbonates of acetyethylamidophenyl, acetylmethylphenyl, acetylamidophenyl, lactylamidophenyl, and for-

1 E. P. 12742, 1912; F. P. 459539, 1913, abst. Mon. Sci. 1914, **81**, C. A. 1914, **8**, 3238. See also E. P. 12743, 12744, 1912.

2 U. S. P. 1090641, 1090642, 1090643, 1090644, 1914; E. P. 12742, 12743, 1912, abst. C. A. 1914, **8**, 1672.

3 E. P. 12745, 1912; abst. J. S. C. I. 1912, **31**, 1042. See F. P. 459541, 1913. E. P. 12743, 12744, 1912; U. S. P. 1280278, 1280279, 1918, abst. J. S. C. I. 1913, **32**, 991, 1918, **37**, 784-A.

4 E. P. 12746, 1912; F. P. 459540, 1913. Austral. P. 9238, 9239, 9240, 9241, 1913.

5 E. P. 4940, 1913, abst. J. S. C. I. 1914, **33**, 712.

6 E. P. 4941, 1913; abst. J. S. C. I. 1914, **33**, 712.

7 U. S. P. 1302202, 1919, abst. J. S. C. I. 1919, **38**, 480-A; U. S. P. 1306440, abst. C. A. 1919, **13**, 2130; J. S. C. I. 1919, **38**, 555-A. U. S. P. 1310489, 1919, abst. C. A. 1919, **13**, 2449. U. S. P. 1303115; abst. C. A. 1919, **13**, 1930. E. P. 16692, 1914. E. P. 14655, 14656, 1915; abst. C. A. 1919, **13**, 1639; J. S. C. I. 1919, **38**, 340-A. E. P. 126056, 1916, abst. J. S. C. I. 1919, **38**, 513-A, C. A. 1919, **13**, 2280. E. P. 128372, 1918; abst. J. S. C. I. 1919, **38**, 486-A. E. P. 131389, 1918; abst. C. A. 1920, **14**, 350. U. S. P. 1338601; abst. C. A. 1920, **14**, 1898. U. S. P. 1280278; abst. C. A. 1918, **12**, 2689.

8 E. P. 18802, 25069, 1899, abst. J. S. C. I. 1902, **21**, 364. See also W. Rintoul and T. Nolan, U. S. P. 1348741, 1920.

9 Belg. P. 261981, 1913.

10 E. P. 5737, 1914; abst. C. A. 1915, **9**, 2313; J. S. C. I. 1915, **34**, 818.

11 E. P. 25434, 1899; abst. J. S. C. I. 1901, **20**, 62. Cie Parisienne de Couleurs d'Aniline, F. P. 295592, 1899.

mylamidophenyl (20 compounds),¹ as well as a series of aromatic sulfonic acid derivatives of the general formula $R\cdot SO_2\cdot A$, where R represents an aromatic radical or its substitution product (phenyl, tolyl, xylyl, naphthyl, nitrophenyl, nitrotolyl, alkyloxyphenyl), and A indicates either an aliphatic or aromatic ether residue of a mono- or poly-valent alcohol.²

F. Raschig³ has obtained protection for nitrocellulose gelat

1. E. P. 24901, 1894, abst. J. S. C. I. 1895, **14**, 100, 1008, 1061. See also Bull. Soc. Franc. Phot. 1901, **17**, II, 373.

2. Meister, Lucius & Bruening, E. P. 25434, 1899, abst. J. S. C. I. 1901, **20**, 62. U. S. P. 758335, 1904. D. R. P. 122272, 1899, abst. Zts. ang. Chem. 1901, **14**, 788; Chem. Centr. 1902, **72**, II, 328, Wag. Jahr. 1901, **47**, I, 609; Mon. Sci. 1901, (4), **57**, 292. Belg. P. 148560, 1900, have evolved a series of camphor substitutes, in which aromatic sulpho acids of the general type $R\cdot SO_2\cdot A$ are used to partially or wholly replace the camphor. In this formula, R represents an aromatic radical or its substitution product such, for instance, as phenyl, tolyl, xylyl, naphthyl, nitrophenyl, nitrotolyl, alkyloxyphenyl, etc. and A indicates either an aliphatic or aromatic ether residue, such as oxalkyl or residue of mono or polyvalent alcohol, for instance, methyl, ethyl, benzyl, cumamyl alcohols, etc. and oxalaphyl or residue of a monovalent or polyvalent phenol, such as phenol, naphthol, cresol, resoremol, dioxydiphenylmethane, etc., or amido group, which, non substituted, may be substituted one or twice. This is an exceedingly important group known under the general name of Plastol. The members constituting it are of more interest at the present time than when they were patented, due to the fact that several have been found to be latent solvents of acetylhydrocelluloses and acetyloxycelluloses. The most important of this group are as follows: benzenesulphamid, *p*-toluenesulphamid, *p*-chlorosulphamid, benzenesulfoethylamid, benzene sulfdiethylamid, *p*-toluenesulphoethylamid, *p*-toluenesulfo diethylamid, acetbenzenesulfoamid, acet-*p*-toluenesulphamid, *p*-chlorbenzenesulphamid, dibenzyl-*p*-chlorbenzenesulphamid, dibenzyl-*p*-toluenesulphamid, dibenzyl-*p*-toluenesulfoamid, benzenesulphamid, *p*-chlorbenzenesulphamid, dibenzyl-*p*-chlorbenzenesulphamid, *p*-toluenesulfoamid, dibenzyl-*p*-toluenesulfoamid. Benzenesulfo-methylamid, ethylamid, *-o*-toluid, *-o*-chloramid, *-o*-phenetidm, *-p*-phenetidm, α -naphthylamm, β -naphthylamm and benzenesulfo diphenylamm, *p*-toluenesulpho-methylamid, *-ethylamid*, *-o*-toluid, *-p*-toluid, *-m*-xyldid, *-p*-chloramid, *-o*-phenetidm, *-p*-phenetidm, β -naphthylamm, β -naphthylamm, diphenylamm, *-phenylhydrazm*, *-acidphenylether*, *-cresol*, β -naphthol, α -naphthol, *-acidethylester*. Benzenesulfo acidphenylether, *-p*-cresol, β -naphthol; dibenzesulfo 2,7-dioxynaphthalam, *p*-chlorbenzenesulfo- β -naphthol, di-*p*-sulfo 2,7-dioxynaphthalam, *p*-chlorbenzenesulphamid, *p*-toluenesulphamido acetic acid, *p*-toluenesulphamido ethyl ester, *-o*-, *-p*-, *-m*-amidosulphobenzoic acid, *-o*-, *-p*-, *-m*-sulphamidoethylester. The melting points of these sixty-three compounds are within the range of pyroxylin decomposition with but few exceptions, and the melting point may be materially lowered in a number of instances by mixing two or more in various proportions, as for instance, a mixture of *p*-toluenesulphamid (m. pt. 137°) and *p*-toluenesulfo monoethylamid (m. pt. 58°) gives a series of melting points at any degree between these two extremes.

3. D. R. P. 174914, abst. J. S. C. I. 1907, **26**, 340, Wag. Jahr. 1906, **52**, II, 927; Jahr. Chem. 1905 8, II, 993, Mon. Sci. 1911, **74**, 63, C. A. 1907, **1**, 1198; Chem. Centr. 1906, **77**, II, 1702. U. S. P. 900204, 1908, abst. C. A. 1909, **3**, 596, J. S. C. I. 1908, **27**, 1082. See also Badische Anilin u. Soda-fabrik, D. R. P. 251351, 1911, abst. Wag. Jahr. 1912, II, 604; C. A. 1913,

inizers of methylcyclohexanol (hexahydro-*o*-cresol), and 1-methylcyclohexanone; the Badische Co.¹ have detailed particulars concerning acetyldicyclohexylamine, *p*-toluenesulfodicyclohexylamine; cyclopentanols, cyclohexanols,² and their corresponding formates and acetates,³ including *b*-methylcyclohexanol formate and acetate, and *b*-methylcyclopentanol formate and acetate. Closely related to these bodies are⁴ methylcyclohexyl,⁵ and di- and tri-dimethylcyclohexene carboxylic acids.⁶

Among other chemicals which have, from time to time, been proposed as accompanists to the cellulose esters to induce specific effects, may be recorded xylamide,⁷ terpineol,⁸ pyrocatechuic aldehyde,⁹ tetrahydromethylpropylbenzene,¹⁰ dihydroxydiphenylsulfone,¹¹ borneol and isborneol esters of dibromdihydrocinnamic

7, 351, 427, 1426; Chem. Ztg. Rep. 1912, **36**, 584; Chem. Ind. 1912, **35**, 657; Zts. ang. Chem. 1912, **25**, 2508; Chem. Zentr. 1912, **83**, 1246; Farb. Ztg. 1912, **17**, 2815. U. S. P. 1045895, 1913, E. P. 3869, 7292, 1912, abst. J. S. C. I. 1912, **31**, 1176; E. P. 3869, 1912; abst. Kunst. 1913, **3**, 94; C. A. 1913, **7**, 2683.

1. U. S. P. 1200886, 1916, E. P. 9270, 1914, abst. J. S. C. I. 1915, **34**, 867, 1916, **35**, 1152. D. R. P. 281225, 1914; abst. C. A. 1915, **9**, 2311; Chem. Zentr. 1915, **86**, I, 238; Kunst. 1914, **4**, 396, 1915, **5**, 9. D. R. P. 284672, 1915, abst. Chem. Zentr. 1915, **86**, II, 111. F. P. 459006, 1913; abst. Mon. Sci. 1914, **81**, 129.

2. U. S. P. 1166790, 1916; E. P. 3869, 1912. E. P. 21367, 21368, 23544, 1912, abst. J. S. C. I. 1913, **32**, 1021; C. A. 1914, **8**, 831. E. P. 4076, 1913. D. R. P. 255692, 1912, abst. Kunst. 1914, **4**, 37; C. A. 1913, **7**, 1815. D. R. P. 263404, 1912, abst. C. A. 1913, **7**, 4088; Kunst. 1913, **3**, 375. D. R. P. 272391, 1912; abst. Kunst. 1914, **4**, 192. Aust. P. 64393, 1912. Swiss P. 62585, 1912, abst. C. A. 1914, **8**, 2224.

3. U. S. P. 1045895, 1912; abst. Mon. Sci. 1913, **78**, 110; C. A. 1913, **7**, 712; J. S. C. I. 1913, **32**, 19. F. P. 440733, 1912, abst. J. S. C. I. 1912, **31**, 828; Kunst. 1912, **2**, 414, 1913, **3**, 17, Mon. Sci. 1914, **80**, 14. E. P. 3869, 1912; abst. C. A. 1913, **7**, 2683; Kunst. 1913, **3**, 94; J. S. C. I. 1912, **31**, 1176. D. R. P. 280377, 1913, abst. Kunst. 1914, **4**, 392. Holl. P. 103, 1914; abst. C. A. 1914, **8**, 2482. Swiss P. 59164, 61611, 1912. D. R. P. 289498, 1913, abst. C. A. 1916, **10**, 2615.

4. P. Sabatier and A. Maihle, Compt. rend. 1904, **140**, 350, abst. Chem. Centr. 1905, **76**, I, 742.

5. J. Sanderens and J. Aboulenc, Compt. rend. 1912, **155**, 1013. R. De Forcrand, Compt. rend. 1912, **154**, 1327.

6. Farbwerke vorm. Meister, Lucius & Bruning, E. P. 11137, 1903.

7. Cie. Generale de Chromolithie, F. P. 254680; abst. Mon. Sci. 1897, **50**, 20.

8. A. Tixier and L. Rambaud, E. P. 17135, 1903; abst. J. S. C. I. 1904, **23**, 990. In this connection see also P. Genvresse, Compt. rend. 1901, **132**, 637; 1902, **134**, 360; abst. J. S. C. I. 1901, **20**, 503; 1902, **21**, 424.

9. G. Stalman and Schimmel & Co., U. S. P. 886085, 1908.

10. H. Blackmore, Can. P. 109502, 1907.

11. Chem. Fabr. Griesheim-Elektron, E. P. 15855, 1909; abst. J. S. C. I. 1909, **28**, 1163; C. A. 1910, **4**, 827. F. P. 404866, 1910. D. R. P. 219918; abst. C. A. 1910, **4**, 2203. Chem. Zentr. 1910, **81**, I, 1080; Chem.

acids,¹ glucose, levulose, dextrin,² and their dibutyrate, distearates, diacetates, pentacetates, ditartrates, tetratartrates, triacetates;³ together with acetochlorhydrose, pentacetyllevulose, tetracetylactose, and saccharose mono-, tetra-, hepta- and octo-acetates. Benzyl- and naphthyl-dihydrocarvon,⁴ acetyl-vanillin,⁵ fenchone,⁶ and dimethylhydrochinon, thymochinon, benzoylguaiacol (bensosol), and thymol.⁷

To one not thoroughly conversant with the immense amount of painstaking research covering nearly two decades, which has been expended on the subjects as outlined above, it might appear that the foregoing was a somewhat formidable selection of chemicals investigated, and perhaps gather the inference that the time and energy expended is out of proportion to the intrinsic importance of the art. But it must be remembered, although whole series of camphor substitutes, gelatinizers and ancillary solvents may have been investigated and abandoned as worthless, some chemist with super-acute discernment by linking up the accumulated information of the past, may evolve a combination which

Ztg Rep 1910, **34**, 168, Chem Ind 1910, **33**, 238; Wag Jahr 1910, **56**, II, 589, Chem Zts 1910, **9**, 1932, Jahr. Chem 1910, **63**, 427. E. P. 15271, 1914, describes the use of vinyl acetate and chloracetate

1. U. S. P. 1026913, 1026914, 1912, abst. C. A. 1912, **6**, 1956. D. R. P. 252158, abst. C. A. 1913, **7**, 402. E. P. 19366, 1911, abst. J. S. C. I. 1912, **31**, 661, C. A. 1913, **7**, 537.

2. Rheinische Gummi u. Celluloidfabrik, D. R. P. 140855, 1902; abst. J. S. C. I. 1903, **22**, 569, Jahr. Chem 1903, **56**, 1019, Chem Centr 1903 **74**, I, 941.

3. Rheinische Gummi u. Celluloidfabrik, D. R. P. 140263, 140480, 168497, 1903, abst. J. S. C. I. 1903, **22**, 569, 1906, **25**, 775, Chem Centr 1903, **74**, I, 905, 906, Jahr. Chem 1903, **56**, 1019, Wag Jahr 1906, **52**, II, 526.

4. B. Szelmiski, D. R. P. 202720, abst. Zts. ang. Chem 1908, **21**, 2428, Chem Zentr 1908, **79**, II, 1837, Chem Ztg Rep 1908, **32**, 594, Wag Jahr 1908, **54**, II, 540. See also U. S. P. 366231.

5. A. Wack and the Verona Chemical Co., U. S. P. 898942, 898943, 1908; abst. C. A. 1909, **3**, 358, J. S. C. I. 1908, **27**, 1041.

6. A. Claessen, E. P. 11365, 1910. F. P. 415737, 1910, abst. J. S. C. I. 1910, **29**, 1084. Can. P. 127966, 1910. D. R. P. 163668, 1904, abst. Chem Centr. 1905, **76**, II, 1568. U. S. P. 979431, 1910, abst. J. S. C. I. 1910, **29**, 1084.

7. J. Stevens and the Celluloid Co., U. S. P. 607554, 1898. See also G. Chazel, Rev. prod. chim. 1918, **21**, 307, 328, 349, 372, 397, 409, 1919, **22**, 63, 89, 177, 201, 559; abst. C. A. 1920, **14**, 589, for the preparation of terpineol, terpine, borneol, bornyl acetate, menthyl acetate, linalyl acetate and similar compounds, many of which have found application in cellulose plastics. J. Crane (U. S. P. 1329583, 1920; abst. J. S. C. I. 1920, **39**, 249-A) has patented a nitrocellulose gelatinizing agent consisting of basic ead acetate. For preparation of p-cymene see Rheinische Kampferfabrik, E. P. 142378, 1919; abst. J. S. C. I. 1920, **39**, 501-A.

produces a result amply repaying for all the toil, expense, heart-aches of those who have labored before.

Proteid Substitutes. In 1821 J. Gorham¹ described an alcohol-soluble proteid obtained from the seeds of maize, which he gave the name of zein, and subsequently investigated by C. Taddei,² H. Link,³ J. Berzelius,⁴ V. Henderson,⁵ E. H. Bracconnot,⁷ and B. Bizio.⁸ This globulin (proteid) has received considerable attention as a camphor substitute in cellulose ester plastics under the names of "maisine," "edist" and "gliadin."

In 1902 T. Osborne and R. Cornelison¹⁰ and E. Donard H. Labbe patented independently the use of this body, and the latter in the following year,¹¹ described in detail its properties. L. Desvaux and H. Allaire,¹² L. Labbe,¹³ L. Nottelle under the name of nitro-epidermose,¹⁵ and J. Geistdorfer¹⁶ gave formulae

1. Quart. J. Sci. Lit. and Arts, 1821, **11**, 206
2. Annals of Phil., May, 1820, Schw. J. 1820, **29**, 514
3. Schw. J. 1815, **14**, 294
4. Pogg. Ann. 1827, **10**, 247
5. Zts. physiol. Chem. 1899, **29**, 47. In U. S. P. 1316854, 1902, J. S. C. I. 1902, **39**, 263 A. Z. Osterberg has described the formation of a non-thermoplastic material of a vegetable prolamme (gliadin, zein) with a small amount of a toughening agent (fat, wax, resin, soap, sulfuric acid, glycerol, phenols, terpenes)
6. Zts. physiol. Chem. 1899, **28**, 253
7. Ann. Chim. Phys. 1827, **34**, 68
8. Brugnatelli's J. fis. chim., etc., 1822, **5**, 127, 180
9. R. Levi, F. P. 381503, 1907
10. U. S. P. 691966, 1902, abst. J. S. C. I. 1902, **21**, 358
11. U. S. P. 714510, E. P. 8876, 28543, 1902, 1474, 1906, F. P. 320027, 361121, D. R. P. 144217, Aust. P. 27203, abst. J. S. C. I. 1902, **21**, 1548, 1903, **22**, 1303, 1905, **24**, 568, 1906, **25**, 554, C. A. 1907, **1**, 1932. See also Compt. rend. 1902, **135**, 744, 1903, **137**, 264, abst. J. S. C. I. 1902, **21**, 1462, 1903, **22**, 960
12. T. Osborne and S. Clapp, Amer. J. Physiol. 1908, **20**, 477, abst. Chem. Zentr. 1908, **79**, I, 1188, J. S. C. I. 1908, **27**, 350. In F. P. 468879, 1915, abst. C. A. 1915, **9**, 2297, A. Labbe has described plastic products from dihydroxy- and trihydroxy derivatives of benzene resorcinol, hydroquinone, pyrogallol, pyrocatechol
13. U. S. P. 929660, 1909, E. P. 9313, 1908, F. P. 388097, 1908 and additions thereto 9309, 10613, abst. C. A. 1908, **2**, 1202, J. S. C. I. 1908, **27**, 873, 956, 1082, 1909, **28**, 1001
14. D. R. P. 251259, abst. Chem. Zentr. 1912, **83**, II, 1247, D. R. P. Ann. I, 35111, abst. Chem. Ztg. 1913, **27**, 387. Aust. P. 57706, abst. Chem. Ztg. 1913, **37**, 188
15. F. P. 347702. The H. Wulkan process for making starch from zein is described in U. S. P. 696156, 1902.
16. E. P. 7735, 1910; 17842, 1912, F. P. 446840, 1912. Holl. P. Ann. 917; Chem. Ztg. 1913, **37**, 953.

urea,¹ urea and guanidine nitrates,² phenylaceto-2-naphthalide,³ and the substituted ureas of O. Thieme⁴ and C. Claessen⁵ have been described. The latter, under the names of Centralite I and II, has been brought into commerce, and comprizing diethyldiphenylurea and tetraphenylurea. The B. Goldsmith thermoplastic⁶ contains urea. Nitrates of guanidine and dicyanodiamidine,⁷ methylurea nitrate,⁸ diurea methylaniline,⁹ terpinene,¹⁰ aquadag,¹¹ and tertiary alcohol urethanes,¹² are bodies which have been proposed for this purpose.¹³ Other efficient stabilizers, some of which have solvent

1. F. Hefti, E. P. 13433, 1913; abst. J. S. C. I. 1913, **32**, 959; C. A. 1914, **8**, 402.
2. B. Flürscheim, E. P. 24702, 1913; abst. J. S. C. I. 1915, **34**, 818; C. Manuelli and L. Bernardini (E. P. 138371) have described guanidine and biguanidine nitrate, and dicyanodiamide.
3. H. Ryan and J. Drumm, Proc. Roy. Irish Acad., 1918, **34**, b, 165; abst. J. S. C. I. 1919, **38**, 741-A; J. C. S. 1919, **116**, 1, 324.
4. U. S. P. 831488, 1906; abst. Mon. Sci. 1907, **67**, 54; C. A. 1907, **1**, 239, 255.
5. D. R. P. 178133; abst. C. A. 1907, **1**, 1352; Chem. Zentr. 1907, **78**, I, 143; Jahr. Chem. 1905 08, II, 993; Wag. Jahr. 1907, **52**, II, 562; Mon. Sci. 1909, **71**, 90; D. R. P. 163668; Chem. Ztg. 1905, **29**, 1149; Bayer. Ind. Gewerbebl. 1907, **39**, 139; D. R. P. 172941; abst. Chem. Centr. 1906, **77**, II, 736; Jahr. Chem. 1905 08, II, 991; Wag. Jahr. 1906, **52**, II, 526; Mon. Sci. 1908, **68**, 45; D. R. P. 172966, 172967, 194874; F. P. 364604; abst. C. A. 1907, **1**, 59; J. S. C. I. 1906, **25**, 906; F. P. 369797; E. P. 16725; 1906; abst. J. S. C. I. 1906, **25**, 1174; C. A. 1908, **2**, 908, 942; E. P. 20037; 1906; abst. C. A. 1907, **1**, 945; J. S. C. I. 1907, **26**, 112; E. P. 21493, 1906; abst. C. A. 1907, **1**, 1928; J. S. C. I. 1907, **26**, 423; E. P. 24839, 1913; Belg. P. 190920, 194658, 1906, 225463, 1910; Aust. P. 27060, 1906. The Westfälsch-Anhaltische Sprengstoff A-G employ amides of organic acids, such as ethyl or methyl acetanilid, to increase the stability and plasticity of smokeless powders; D. R. P. 296591, 1917; abst. Chem. Zentr. 1919, **90**, II, 34.
6. U. S. P. 964964, 1910; abst. C. A. 1910, **4**, 2744.
7. A. Marin, E. P. 121294, 1919; abst. J. S. C. I. 1919, **38**, 699-A. Cf. Cyanid. Ges. m. b. H., E. P. 27515, 1903; abst. Arms & Explos. 1905, **13**, 10.
8. H. Backer, Verslag Akad. Wetensch. **22**, 770, Rec. Trav. Chim. Pays-Bas, 1915, **34**, 187; abst. C. A. 1914, **8**, 2346, 1915, **9**, 2383.
9. J. Walters; Zts. ang. Chem. 1911, **24**, 62; abst. Zts. Chem. Ind. Koll. 1912, **10**, 110; H. Hodgkinson, E. P. 17456, 1888; and C. Lundholm and C. Hsieh, E. P. 7301, 1890; employ aniline for the same purpose.
10. K. Ohno, E. P. 16978, 1913; abst. J. S. C. I. 1914, **33**, 614.
11. P. Maury, F. P. 449858; abst. Chem. Ztg. Rep. 1913, **37**, 304; C. A. 1913, **7**, 3229; J. S. C. I. 1913, **32**, 509.
12. E. Merck & Co., E. P. 159, 1913; abst. J. S. C. I. 1913, **32**, 768.
13. J. Bucher, Can. P. 182110, 1918; abst. C. A. 1918, **12**, 703. See also Can. P. 173309; abst. C. A. 1918, **12**, 156; K. Heresheimer, C. Bosch and A. Mittasch, U. S. P. 1292019; abst. C. A. 1919, **13**, 963; J. S. C. I. 1919, **38**, 268-A; E. P. 24042, 1914; abst. J. S. C. I. 1916, **35**, 71; E. Yamazaki, J. Tokyo Chem. Soc. 1918, **30**, 125-84; cf. C. A. 1914, **8**, 3309; 1915, **9**, 89; abst. C. A. 1919, **13**, 1509; H. de Vries, Zts. physik. Chem. 1889, **3**, 104; Fab. de Produits de Chimie Organique de Laire, E. P. 5533, 1913; E. P. 17501, 1914.

action on the cellulose nitrates are diphenylamine,¹ dinitrodi-
 • phenylamine,² diphenylbenzidine,³ acetyldiphenylamine,⁴ formyl-di-
 phenylamine, acetylphenyltolylamine, acetylphenylnaphthylamine,⁵
 and amidobenzenesulfoazodiphenylamine.⁶

Solvent Recovery. Inasmuch as comparatively speaking—the cellulose esters have but few uses in the dry state, and only exhibit their value and usefulness when dissolved or plastified, the recuperation of nitrocellulose solvents becomes an important branch of the Technology of Cellulose Esters.

The majority of the processes combine refrigeration of the attenuated admixture of solvent vapor and air with expansion and contraction of the gas-laden atmosphere by a combination of heating or cooling with pressure or partial vacuum. Among such processes may be mentioned the methods of H. Barbet,⁷ T. Baker,⁸ J. Aurenque,⁹ A. Barbezat,¹⁰ K. Barth,¹¹ E. Barstow and J. Griswold, Jr.,¹² E. Bataille,¹³ J. Baudot,¹⁴ F. Bird,¹⁵ W. Bocken-
 • hagen,¹⁶ B. Borzykowski,¹⁷ E. Bouchard-Praceiq,¹⁸ G. Catala,

1. E. duPont de Nemours & Co., U. S. P. 1314538, abst. J. S. C. I. 1919, **38**, 813-A; C. A. 1919, **13**, 2682; J. Soc. Dyers Col. 1920, **36**, 23. Can. P. 186822, 186823, 186824, 186825, 1918. Cf. J. Delpach, F. P. 436439. The Dunlop Rubber Co., Can. P. 190042, 1920. H. and P. Ryan, Proc. Roy. Irish Acad. 1918, **34**, b, 194-240, 212-217; abst. J. S. C. I. 1919, **38**, 742-A. C. van Duin and B. van Lennep, Rec. trav. Chim. Pays-Bas, 1919, **38**, 358; abst. J. S. C. I. 1920, **39**, 151-A.

2. E. duPont de Nemours & Co., U. S. P. 1309580, abst. J. S. C. I. 1919, **38**, 676-A.

3. L. Smith, Zts. anal. Chem. 1917, **56**, 28-42, J. C. S. 1917, **112**, ii, 217; abst. C. A. 1917, **11**, 2759.

4. E. Franquet, F. P. 312817, 1901, abst. Mon. Sci. 1903, **59**, 12, J. S. C. I. 1902, **21**, 134.

5. Deutsche Celluloidfabrik, E. P. 12863, 1901, abst. J. S. C. I. 1902, **21**, 494.

6. E. Lajoanio, F. P. 452154, abst. Mon. Sci. 1914, **81**, 51; C. A. 1913, **7**, 3665.

7. U. S. P. 1326432, 1919; E. P. 101723, 1916, abst. C. A. 1920, **14**, 603; J. S. C. I. 1918, **27**, 45-A, 1920, **39**, 145-A. F. P. 379039, 1906; 432569, Add. March 29, 1911; abst. J. S. C. I. 1907, **26**, 1190, 1912, **31**, 112.

8. U. S. P. 1218616, 1917; abst. C. A. 1917, **11**, 1532.

9. F. P. 349843, 1904.

10. F. P. 372524, 1906; Add. March 3, 1906, abst. J. S. C. I. 1907, **26**, 518, 673.

11. U. S. P. 1264479, 1918; abst. J. S. C. I. 1918, **37**, 398-A.

12. U. S. P. 1261005, 1918; abst. J. S. C. I. 1918, **37**, 398-A.

13. • F. P. 387325, 1907, abst. J. S. C. I. 1908, **27**, 819. E. and R. Bataille, F. P. 491352, 491353, 1915.

14. F. P. 413442, 1910.

15. E. P. 25772, 1901; abst. J. S. C. I. 1903, **22**, 15, 43.

16. Chem. Ztg. 1911, **35**, 1240; abst. Zts. ang. Chem. 1911, **24**, 2104;

1906,
 19798,
 Jahr. 1906,
 14. F. .
 494; 1909, **28**, 2.
 15. F. P. 426,
 16. E. P. 15372,
 362611, 1906; abst J. S.
 1905; 197313, 1907.
 17. E. P. 4070, 1915; abst
 18. U. S. P. 503586, 1893, 1.
 1218616, 1228225, 1230719, 1917; 12.
 17618, 1910; 10351, 24296, 1914, 12668.
 1919. E. Appl 4276, 11182, 11183, 1919,
 1911, **30**, 1037; 1914, **33**, 65; 1915, **34**, 601, 1.
 869, 1087; 1919, **38**, 160-A, 269-A, 305-A, 3.
 1915, **9**, 2727; 1919, **13**, 1152, 1920, **14**, 101, 211. Ca.

15. G. G. Goss, *Trans. Expl.* 1899, **7**, 19. D. R. P. 110289, *abst. Wag. Jahr* 1900, **46**, I, 397.
16. F. P. 352298, 1905, *abst. J. S. C. I.* 1905, **24**, 981.
17. F. P. 349997, 1901, *abst. J. S. C. I.* 1905, **24**, 1004.
18. Chinn et Ind. 1918, **1**, 481, *abst. C. A.* 1919, **13**, 364.
19. F. P. 403682, 1916, 12790, 1917, *abst. C. A.* 1917, **11**, 1760, *J. S. C. I.* 1919, **38**, 319 T.
20. F. P. 23150, 1913, *abst. C. A.* 1915, **9**, 964.
21. F. P. 116590, 1917, *abst. J. S. C. I.* 1918, **37**, 393 A, 195 A.
22. U. S. P. 904636, 1908, E. P. 36641, 1906, F. P. 363519, 1906, D. R. P. 198703, 1905, Swiss P. 42181, 1907, Can. P. 99456, 1906, *abst. J. S. C. I.* 1906, **25**, 868, 1908, **27**, 1223, C. A. 1907, **1**, 506, *Zts. ang. Chem.* 1908, **21**, 1660, *Chem. Zentr.* 1908, **79**, 11, 276, *Chem. Ztg. Rep.* 1908, **32**, 377. India P. Appl. 356, 1906, Austral. P. 5961, 1906. Dan. P. 9102, 1906.
23. F. P. 111210, 1919, *abst. J. S. C. I.* 1920, **39**, 392 A.
24. F. P. 455879, 1913, *abst. C. A.* 1914, **8**, 2040, *Chem. Ztg. Rep.* 1914, **38**, 62.
25. F. P. 444159, 1912, *abst. J. S. C. I.* 1912, **31**, 1148.
26. F. P. 5368, 1913, *abst. C. A.* 1914, **8**, 2962, *J. S. C. I.* 1914, **33**, 428.
27. *Annali. Chim. Appl.* 1918, **10**, 117, *abst. C. A.* 1919, **13**, 997, *J. S. C. I.* 1919, **38**, 123 T.
28. Belg. P. 211270, 1908.
29. F. P. 424242, Add. 11084, 1911, Belg. P. 234732, 1911.

et l'Exploitation des Procédés Georges Claude),¹ Société Anonyme pour la Fabrikation de la Soie de Chardonnet,² Société pour la Fabrikation en Italie de la Soie Artificielle par le Procédé de Chardonnet,³ C. Tuckfield and W. Garland,⁴ A. Zeckendorf and Maschinenbau Aktiengesellschaft Golzern Grimma,⁵ S. Zipser,⁶ A. Vincent,⁷ T. Taylor and J. Taylor & Co.,⁸ J. Spenle,⁹ J. Mills and H. Battle,¹⁰ G. Meunier,¹¹ C. Mayo,¹² C. Weber and I. Frankenburg, Ltd.,¹³ Société Anonyme des Plaques et Papiers Photographiques A. Lumière et ses Fils,¹⁴ J. Smith, H. Mitchell, W. Askham, and H. Hey,¹⁵ W. Rowland,¹⁶ P. Razous,¹⁷ T. Naughton,¹⁸ G. May and W. Grosvenor,¹⁹ H. Maxim,²⁰ C. Hopewell,²¹ H. de Groussilliers,²² A. Gray,²³ L. Bonneau and V. Hasenfratz,²⁴ I. Levy,²⁵ C. Hopewell,²⁶

1. U. S. P. 1040886, 1912; E. P. 5395, 1909; F. P. 397791; Add. July 16, 1909, 413571, 1909; 425092, 435073, 1910; D. R. P. 229001, 1909; Belg. P. 214250, 1909; abst. J. S. C. I. 1909, **28**, 880; 1912, **31**, 321, 1020; Kunst. 1912, **2**, 212.
2. F. P. 376785, 1906; 387054, 1908; abst. J. S. C. I. 1907, **26**, 1040; 1908, **27**, 803.
3. F. P. 371985, 1906; abst. J. S. C. I. 1907, **26**, 468, 483. See Kunst.-faclen Ges., F. P. 371544, 1906; abst. J. S. C. I. 1907, **26**, 468, 483.
4. E. P. 26360, 1903; abst. J. S. C. I. 1904, **23**, 1039.
5. F. P. 434949, 1911. D. R. P. 235300, 1911; abst. C. A. 1914, **8**, 1193.
6. E. P. 12321, 1912, Belg. P. 246232, 1912.
7. U. S. P. 849645, 1907; F. P. 361603, 1906; abst. J. S. C. I. 1906, **25**, 996; 1907, **26**, 539.
8. E. P. 21503, 1909.
9. E. P. 17780, 1907; F. P. 387594, 1908; abst. J. S. C. I. 1908, **27**, 746, 803.
10. E. P. 1550, 1909; abst. J. S. C. I. 1909, **28**, 945.
11. E. P. 13018, 1911. Reference is made to E. P. 12207, 1911.
12. E. P. 8600, 1909, 13340, 1911. See E. P. 17125, 22615, 1909.
13. E. P. 16919, 1901; F. P. 319239, 1902; D. R. P. 134303; abst. J. S. C. I. 1902, **21**, 968, 1461; Wag. Jahr. 1902 **48**, II, 479.
14. F. P. 361323, abst. Mon. Sci. 1907 **67**, 599.
15. E. P. 17435, 1904; 18605, 1909; F. P. 356678, 1905; abst. J. S. C. I. 1905, **24**, 1053, 1292.
16. U. S. P. 1069033, 1913; abst. C. A. 1913, **7**, 3241.
17. L'Industrie Chim. 1919, **6**, 169, 195, 229; abst. C. A. 1920, **14**, 314.
18. U. S. P. 815463, 1906; abst. J. S. C. I. 1906, **25**, 386.
19. E. P. 10795, 1909; abst. J. S. C. I. 1909, **28**, 484.
20. U. S. P. 430215, 1890. E. P. 18663, 1888; abst. J. S. C. I. 1889, **3**, 160, 946, 1010.
21. U. S. P. 1063686, 1913; abst. C. A. 1913, **7**, 2477; J. S. C. I. 1913, **32**, 741.
22. E. P. 13562, 1895; abst. J. S. C. I. 1895, **14**, 886.
23. E. P. 19710, 1891; 9565, 19175, 1894; D. R. P. 87684; abst. J. S. C. I. 1892, **11**, 904; 1895, **14**, 862; Wag. Jahr. 1896, **42**, 1067.
24. E. P. 10780, 1914; abst. J. S. C. I. 1915, **34**, 1004.
25. E. P. 137615, 1920; abst. J. S. C. I. 1920, **39**, 214-A.
26. U. S. P. 1063686, 1913; abst. Chem. Ztg. 1913, **37**, 741.

A. Lehner,¹ W. Lewis and W. Green,² H. Wehner,³ H. Schmidt,⁴ A. Páirs,⁵ O. Overbeck,⁶ and A. O'Brien.⁷ In all of the above processes, the claim to novelty has rested primarily upon the employment of physical means for recuperations frigorifically.

Many other processes for solvent captation depend upon the solvent influence of inorganic salts or immiscible liquids. The solvents usually regained are ethyl alcohol, ethyl ether, acetone and amyl acetate. The use of sulfuric acid has long been used for the winning of alcohol, the processes of G. Leroy,⁸ Societe J. Jean & Co. and G. Raverat,⁹ Fabrique de Soie Artif. de Tubize,¹⁰ J. Dervin,¹¹ H. Barthelemy,¹² and E. Barbet et Fils et Cie,¹³ being based upon the capacity of the combination of alcohol and acid to the formation of ethylsulfuric acid.

Haloid substituted aliphatic hydrocarbons,¹⁴ as carbon tetrachloride,¹⁵ trichlorethylene,¹⁶ alone or in the presence of aluminum chloride¹⁷ or calcium or magnesium chloride¹⁸ have been

1. D. R. P. 303396, 1916; abst. J. S. C. I. 1920, **39**, 214-A.
2. Can. P. 199907, 199908, 1920.
3. D. R. P. 314548, 1918, abst. J. S. C. I. 1920, **39**, 258-A.
4. E. P. 141739, 1920. See A. Wohl, F. P. 435742, 1911.
5. Can. P. 178609, 1917.
6. E. P. 5170, 1911; abst. J. S. C. I. 1911, **30**, 354.
7. Can. P. 199796, 1920.
8. Belg. P. 206404, 208526, 209823, 1908.
9. E. P. 13601, 13602, 13603, 1905, F. P. 345138, 1904, Add. 4212, 1904; 350047, 350149, 1904; Belg. 185425, 1905; abst. J. S. C. I. 1904, **23**, 1231; 1905, **24**, 750, 1082; 1906, **25**, 58, 773, 777, Mon. Sci. 1907, **66**, 34.
10. E. P. 11729, 1910, F. P. 401262, 1908, 412887, 1909, Aust. P. 47780, abst. J. S. C. I. 1910, **29**, 1004. Belg. P. 225669, 1910.
11. F. P. 350298, 1904, Add. 5717, 1905, abst. J. S. C. I. 1906, **25**, 71, 925. See E. Barbomi, F. P. 350313, 1904, abst. C. A. 1907, **1**, 1497.
12. Mat. Grasses, 1914, **7**, 4208, 4236, 4240, 4247; 4251; abst. J. S. C. I. 1914, **33**, 915; C. A. 1915, **9**, 245, 1259.
13. E. P. 101723, 101875, 1916, 117259, 1918, abst. J. S. C. I. 1918, **37**, 45-A, 1919, **38**, 448 A, 319-T; C. A. 1917, **11**, 280; 1918, **12**, 2417. In this connection see J. Duclaux, D. R. P. 256857, 1912, abst. C. A. 1913, **7**, 2480. Hegel (Kunst. 1920, **10**, 25, 43; C. A. 1920, **14**, 2088) has reviewed the methods for the recovery of solvents in the artificial silk industry, with 34 patents cited.
14. T. Chandelon, D. R. P. 254913, 1912, Belg. P. 254511, 1913; abst. C. A. 1913, **7**, 1296; Wag. Jahr. 1912, **58**, II, 444, Kunst. 1913, **3**, 50, 355.
15. E. Besemfelder, E. P. 14418, 1913.
16. A. Debuisne, F. P. 457838; abst. C. A. 1914, **8**, 2820; Chem. Ztg. Rep. 1914, **38**, 272.
17. J. de Sauversac, F. P. 420086, 1909, abst. C. A. 1912, **6**, 1992.
18. Societe pour la Fabrikation en Italie de la Soie Artificielle par le Procédé de Chardonnet, F. P. 367803, 1906; Add. 7469, 1907; 371985. Belg. P. 201068, 1907; abst. J. S. C. I. 1906, **25**, 1144. D. R. P. 203649.

patented. Glycerol,¹ sodium bisulfite,² vaseline,³ oleic acid,⁴ animal and vegetable oil emulsions with water,⁵ and especially cresol⁶ have been used for the recovery of alcohol-ether and acetone vapors. The latter has recently been extensively used in England and France for this purpose under the patents of J. Bregeat.⁷ Formic, acetic,⁸ and lactic acids;⁹ chloroform,¹⁰ propyl, butyl, amyl, capryl and octyl alcohols,¹¹ have been used for the fixation of alcohol and ether. A. Wohl uses a finely divided cellulose ester as an absorbent;¹² while the methods of W. Nash¹³ and G. Koeber represent unimportant deviations from those indicated above.¹⁴ In some industries—i. e., the manufacture of photographic films—as high as 92% solvent recovery is maintained on factory operations.

Handling of Solvents. In the storage, mixing, filtration,

1. C. Harrison, W. Bate and W. Perks, U. S. P. 1022416, 1912; E. P. 9941, 23888, 1907; F. P. 381529, 1907, abst. J. S. C. I. 1908, **27**, 140, 551, 1196; 1912, **31**, 459.
2. R. Robertson and W. Rintoul, U. S. P. 723311, 1903; E. P. 25994, 1901; F. P. 329540, 1903, abst. J. S. C. I. 1903, **22**, 441, 512, 1063, Mon. Sci. 1903, **59**, 163. D. R. P. 154124, abst. Wag. Jahr. 1904, **50**, I, 347, Arms Expl. 1903, **11**, 64. Ind. P. 507, 1902.
3. P. Armingeat, Belg. P. 195690, 1906, 198897, 1907.
4. O. Bucquet, F. P. 386833, 1908, D. R. P. 196699, 1907; Belg. P. 185537, 1905, 197741, 198725, 1907, abst. C. A. 1909, **3**, 1094; J. S. C. I. 1908, **27**, 558, 715, Zts. ang. Chem. 1908, **21**, 1194; Chem. Zentr. 1908, **79**, I, 1438, Chem. Tech. Rep. 1908, **32**, 240; Chem. Ind. 1908, **31**, 250, Wag. Jahr. 1908, **54**, II, 360.
5. H. Frischer, E. P. 7098, 1915, abst. J. S. C. I. 1916, **35**, 681, C. A. 1916, **10**, 2788.
6. E. Huss and F. Kummel, F. P. 380275, 1907.
7. U. S. P. 1315700, 1315701, 1919; E. P. 128640, 131938, 1917, Can. P. 195703, 1920; abst. C. A. 1919, **13**, 2983, 1920, **14**, 326; J. S. C. I. 1918, **37**, 194-A, 1919, **38**, 516-A, 621-A, 751-A, 855-A. A. Daniel and J. Bregeat, E. P. 127309, 1917; abst. J. S. C. I. 1919, **38**, 319-T, C. A. 1919, **13**, 2428.
8. A. Berge, Belg. P. 250816, 1912.
9. A. Lointier, Belg. P. 253805, 253831, 1913, abst. Kunst. 1913, **3**, 357. Chimiste, **3**, 5, abst. C. A. 1912, **6**, 1503.
10. J. Delpech, F. P. 441555, 1912.
11. A. de Chardonnet, F. P. 376785, 377673, 1906; 413359, 1909; abst. Kunst. 1911, **1**, 75. D. R. P. 207554, 1909, abst. C. A. 1909, **3**, 2035; Zts. ang. Chem. 1909, **22**, 653, Chem. Zentr. 1909, **80**, I, 1293; Chem. Tech. Rep. 1909, **33**, 164, Chem. Ind. 1909, **32**, 187, Wag. Jahr. 1909, **55**, II, 389. Aust. P. 37551, 1909, Belg. P. 225728, 1910.
12. F. P. 23095, 1911; F. P. 435742, 1911; D. R. P. 241973, 1910; Belg. P. 240045, 241116, 1911; abst. C. A. 1912, **6**, 2170; 1913, **7**, 1415; J. S. C. I. 1911, **30**, 1340.
13. U. S. P. 1293315, 1919, abst. C. A. 1919, **13**, 1149; J. S. C. I. 1919, **38**, 340-A.
14. Harburger Eisen- und Bronzewerke Akt. Ges. and G. Koeber, E. P. 28261, 1913. See E. P. 27014, 1913.

weighing, transportation and sampling of solvents many processes have been proposed and apparatus perfected, whereby the inflammable nature of the solvents is taken into consideration.

Processes for the filtration of pyroxylin solutions and solvents have been described by A. Boisson,¹ Societe Anonyme pour la Fabrication de la Soie de Chardonnet,² Chemische Fabrik Gustom,³ M. Denis,⁴ F. DuPont,⁵ W. Flemming,⁶ J. Kransfeld,⁷ O. Kremer,⁸ J. Malfitano,⁹ L. Morane,¹⁰ E. Oberle and H. Newbold,¹¹ R. Schilling,¹² E. Sweetland,¹³ Societe Anonyme des Plaques et Papiers Photographiques A. Lumiere et ses Fils,¹⁴ Societe Anonyme les Etablissements Poulenc and F. Billon,¹⁵ Societe Anonyme de Filtre Chamberland Systeme Pasteur,¹⁶ J. Utley,¹⁷ and B. Wright.¹⁸

The storage and transportation of inflammable liquids and collodion combinations has received much thought, due to the various state and national regulations which have been put into force from time to time to minimize the danger from accidents and to reduce the loss due to evaporation to the least limit. Processes of this nature have been brought forward by L. Atkins,¹⁹

- 1 F. P. 436555, 1911, abst. J. Soc. Dyers Color. 1912, **28**, 199.
- 2 F. P. 354398, 1905, 478405, 1914, abst. J. S. C. I. 1916, **35**, 1009, Mon. Sci. 1908, **69**, 21.
- 3 Hung. Ann. G. 3460.
- 4 D. R. P. Ann. D. 23746, 1910.
- 5 F. P. 419072, 419073, 419074, 419075, 419076, 419077, 419078, 419752, 1910, abst. J. S. C. I. 1911, **30**, 120.
- 6 D. R. P. Ann. F. 33299, 33300, 1911, abst. Kunst. 1912, **2**, 399.
- 7 Neues Erfindungen Erfahr. 1889, **16**, 516.
- 8 Phot. Corr. 1871, **8**, 69.
- 9 F. P. 401926, 1909, D. R. P. Ann. M. 40810, 1910.
- 10 D. R. P. Ann. M. 41269, 1909. L. Desmarais and G. Morane, E. P. 6783, 1905.
- 11 F. P. 258287, 1896. See Compagnie des Recipients et Lampes Inexplosibles, F. P. 318307, 1902, E. P. 12183, 1902, abst. J. S. C. I. 1902, **21**, 1126, 1445.
- 12 D. R. P. 230251, 1909; 230252, 1910, abst. Chem. Ztg. Rep. 1911, **35**, 76, 167.
- 13 U. S. P. 1304918, 1919, E. P. 7469, 1915, abst. C. A. 1916, **10**, 2653, 1919, **13**, 1961.
- 14 F. P. 361329, 1905.
- 15 F. P. 420319, 1909. J. and O. Erwin, E. P. 2142, 1914, U. S. P. 1085805, abst. J. S. C. I. 1915, **34**, 20.
- 16 E. P. 16270, 1911, abst. J. S. C. I. 1911, **30**, 1331, C. A. 1913, **7**, 5.
- 17 F. P. 410111, 1909, Add. 12769, 1910.
- 18 U. S. P. 1032641, 1912; abst. J. S. C. I. 1912, **31**, 801.
- 19 J. Ind. Eng. Chem. 1917, **9**, 979, abst. C. A. 1917, **11**, 3099.

C. Allenou,¹ G. Arnstein,² F. Baxter,³ Breitschuh & Vorbrodt,⁴ H. Bruun,⁵ E. Calthrop,⁶ N. and L. Champy,⁷ C. Topham,⁸ F. Clauss and L. Lewisson,⁹ La Compagnie des Recipients et Lampes Inexplosibles,¹⁰ H. van Eicken,¹¹ Fabrik Explosionssicherer Gefäße,¹² Grüner & Grimberg Ges.,¹³ H. Held,¹⁴ H. Hoffmann,¹⁵ M. Jasper,¹⁶ J. Keay,¹⁷ H. Lange and C. Ruppel,¹⁸ G. Lunn,¹⁹ Maschinenbau Gesellschaft Martini & Hüneke,²⁰ K. Müller,²¹ C. Oehrich,²² O. Ohnesorge,²³ V. Posno,²⁴ J. Pintsch Akt.-Ges.,²⁵ M. Rakusin,²⁶ J. Rolland and P. Maclere,²⁷ T. Rosenthal,²⁸ A. Rosseau,²⁹ C. Ruppel,³⁰ R. Strachan and J. Robertson,³¹ H. Strache,³² O.

1. U. S. P. 710091, 1902, abst. J. S. C. I. 1903, **22**, 16.
2. Aust. Ann. 541, 1914; abst. C. A. 1916, **10**, 2058.
3. J. Ind. Eng. Chem. 1917, **9**, 978; abst. C. A. 1917, **11**, 3100.
4. D. R. P. 288583, 1913; abst. C. A. 1916, **10**, 2523.
5. E. P. 1494, 1495, 1912
6. E. P. 7888, 1913.
7. E. P. 21850, 1912, abst. J. S. C. I. 1913, **32**, 1001.
8. E. P. 5760, 1905; J. S. C. I. 1906, **25**, 333.
9. E. P. 28698, 1906; abst. J. S. C. I. 1908, **27**, 112.
10. E. P. 12183, 1902; abst. J. S. C. I. 1902, **21**, 1126.
11. E. P. 15195, 1911; 23420, 1912; abst. C. A. 1913, **7**, 223.
12. Pharm. J., Feb. 23, 1901; abst. J. S. C. I. 1901, **20**, 293.
13. E. P. 9628, 1910; D. R. P. 213123, 231919, 1910; abst. J. S. C. I. 1910, **28**, 1047; C. A. 1912, **6**, 1824.
14. F. P. 464337, 1913; abst. J. S. C. I. 1914, **33**, 470.
15. E. P. 248, 0883, 1913; 12328, 1914; abst. J. S. C. I. 1915, **34**, 2999.
16. E. P. 18334, 1912.
17. E. P. 21999, 1901, abst. J. S. C. I. 1902, **21**, 1445.
18. D. R. P. 286361, 287748, 287789, 1911, abst. C. A. 1916, **10**, 1701, 2286, 2300.
19. E. P. 5213, 1912, D. R. P. 270043, 1911, abst. C. A. 1914, **8**, 2281.
20. U. S. P. 871353, 1907; 962036, 1910; 1186269, 1913; E. P. 4233, 1903, 489, 57709, 1907; 19691, 19692, 1909; 14707, 1910; 11252, 1911; 1941, 1912; 15263, 22400, 22515, 1913; F. P. 337733, 1903; 359103, 1905; 406527, 406528, 1909; Add. dated Aug. 27, 1909, to 359018; abst. J. S. C. I. 1907, **26**, 1078, 1129, 1270; 1910, **29**, 337, 478; 1912, **31**, 422; 1914, **33**, 13, 64; 1916, **35**, 823. See Hüneke, Chem. Ind. 1903, **20**, 503; abst. J. S. C. I. 1903, **22**, 1188.
21. E. P. 27559, 1911; 8982, 1913.
22. D. R. P. 236427, 1910; abst. C. A. 1912, **6**, 1988.
23. Montan Rundschau 1916, **8**, 409; Chem. Zentr. 1916, **87**, II, 615; C. A. 1917, **11**, 2040.
24. E. P. 14391, 1901; abst. J. S. C. I. 1902, **21**, 700.
25. D. R. P. 258543, 1911; 258634, 258684, 1912; abst. C. A. 1913, **7**, 3205.
26. Caout. et Gutta. 1908, **5**, 2504.
27. E. P. 27001, 1912; abst. C. A. 1914, **8**, 1666.
28. Zts. ang. Chem. 1911, **24**, 289; abst. J. S. C. I. 1911, **30**, 348.
29. F. P. 465586, 1913; abst. C. A. 1914, **8**, 3387.
30. E. P. 14633, 1911; abst. J. S. C. I. 1911, **30**, 1044.
31. E. P. 10190, 1901; abst. J. S. C. I. 1902, **21**, 904.
32. Zts. Ver. Gas Wasserfachm. 1915, **55**, 191, 209; abst. C. A. 1915, **9**, 3127.

Schmidt and F. Struwe,¹ G. Vernon,² R. Ziller,³ W. Boehm,⁴
 † Claus and L. Lewisson,⁵ B. Diamond,⁶ K. Muller,⁷ E. Teisler,⁸
 ‡ Baxter⁹ and L. Adkins.¹⁰

In the weighing and partitioning of inflammable fluid mixtures, the methods as described by C. Beckwith¹¹ and W. Penard¹² are applicable. The explosibility and combustibility of the solvent vapor may be reduced and kept under control by the precautions shown by M. Breslauer,¹³ W. Graaff & Co.,¹⁴ A. Flachs,¹⁵ J. Meunier,¹⁶ and M. Richter.¹⁷ O. Güttmann¹⁸ has detailed the construction preferred for buildings in which inflammable and explosive products are to be stored. For filling receptacles,¹⁹ and sampling,²⁰ processes have been devised. In this connection, attention should be directed to the mixing devices of F. Berberich,²¹ Compagnie pour la Fabrikation des Compteurs et Matériel d'Usines à Gaz,²² G. Walker, F. Sharp and T. Stevens.²³ The J. Criggal²⁴ pump has been designed for this purpose.

Improved and safe methods of economically handling large bulks of solvent and pyroxylin mixtures have been described by

1. D. R. P. 236369, 1909; 237834, 1910, abst. C. A. 1912, **6**, 1988.
2. F. P. 474065, Add. 19623, 1914; abst. C. A. 1915, **9**, 2826.
3. E. P. 25495, 1911; abst. C. A. 1913, **7**, 1432.
4. E. P. 11004, 1911; abst. C. A. 1912, **6**, 1432; J. S. C. I. 1912, **31**, 64.
5. E. P. 28698, 1906; abst. J. S. C. I. 1908, **27**, 112.
6. E. P. 5206, 1909; abst. J. S. C. I. 1909, **28**, 1239.
7. E. P. 8982, 1913.
8. E. P. 7597, 1900; abst. J. S. C. I. 1900, **19**, 646.
9. J. Ind. Eng. Chem. 1917, **9**, 978, abst. J. S. C. I. 1917, **36**, 1226.
10. J. Ind. Eng. Chem. 1917, **9**, 979; abst. J. S. C. I. 1917, **36**, 1226.
11. U. S. P. 1030378, 1912.
12. Arch. Suikerind. 1915, **23**, 699, 1116; abst. C. A. 1916, **10**, 832.
13. C. Tonjes, Arch. Suikerind. 1915, **23**, 1056; abst. C. A. 1916, **10**, 832.
14. U. S. P. 990521, 1911; abst. J. S. C. I. 1911, **30**, 673.
15. E. P. 17156, 1908; abst. J. S. C. I. 1909, **28**, 303.
16. E. P. 8089, 1910; abst. J. S. C. I. 1910, **29**, 1049.
17. Compt. rend. 1907, **144**, 1107; abst. J. S. C. I. 1907, **26**, 714.
18. J. Soc. Dyers Col. 1907, **23**, 263.
19. Zts. Schiess. Spreng. 1910, **5**, 265; abst. J. S. C. I. 1910, **29**, 930.
20. Cf. J. S. C. I. 1908, **27**, 669; abst. C. A. 1908, **2**, 2621.
21. T. Coupe, E. P. 16984, 1901; abst. J. S. C. I. 1902, **21**, 1126.
22. E. Schmitz, Les Matieres Grasses, 1914, **7**, 4194; abst. J. S. C. I. 1914, **33**, 905.
23. D. R. P. 271432, 1912; abst. J. S. C. I. 1914, **3**, 469. F. Berberich and W. Schröder, E. P. 8895, 1905.
24. E. P. 27703, 1910; F. P. 420733, 1909; abst. J. S. C. I. 1911, **30**, 347, 880.
25. E. P. 23189, 1910; abst. J. S. C. I. 1911, **30**, 1239.
26. E. P. 9758, 1913; abst. J. S. C. I. 1914, **33**, 477.

H. Tetley and J. Clayton,¹ B. Dunn,² J. Arnott,³ M. Eisenhart,⁴ H. French,⁵ Grüner & Grimberg,⁶ N. Laury,⁷ H. von Eicken and Maschinenbau Akt. Ges.,⁸ Á. Politzer,⁹ F. Sheppee and M. Shipley,¹⁰ and J. Smith.¹¹

Paint and Varnish Removers. Many compounds are obtainable for the purpose of removing old paint, varnish and enamel from wood or metal surfaces which, in general, either owe their efficiency to the presence of corrosive acids or caustic alkalis, or are combinations of solvents in which the solvent evaporative tendency is diminished by the presence of fatty or waxy material, or a substance of high boiling point.

H. de Briou was apparently the first to submit a definite formula for the removal of paint and varnish film, the process being published in 1864,¹² this being followed by the German process of M. Meyer in 1884.¹³ In 1892 J. Ball¹⁴ received patent protection for a paint remover containing benzol, fusel oil and alcohol which differed from the previous compounds in that all the solvents were anhydrous. Three years later¹⁵ appeared the process of H. Crowther containing nitrobenzene, the C. Ellis¹⁶ and W. Gill¹⁷ patents being issued in 1902. The E. Miller process involving the use of ethyl butyrate,¹⁸ the method of G. Osborne

1. E. P. 17876, 1907.
2. Eng. and Min. J., July 17, 1909, abst. J. S. C. I. 1909, **28**, 854.
3. E. P. 126375, 1917; abst. J. S. C. I. 1919, **38**, 489-A.
4. J. Ind. Eng. Chem. 1917, **9**, 980, abst. C. A. 1917, **11**, 3099.
5. U. S. P. 1062565, 1913, abst. J. S. C. I. 1913, **32**, 740.
6. D. R. P. 236157, 1910, abst. C. A. 1912, **6**, 1988.
7. Met. Chem. Eng. 1917, **17**, 407, abst. J. S. C. I. 1917, **36**, 1169, C. A. 1917, **11**, 3098.
8. U. S. P. 1004287, 1911, E. P. 29573, 1912, F. P. 406529, D. R. P. 282367, 1913; abst. C. A. 1915, **9**, 2588.
9. F. P. 455879, 1913, abst. C. A. 1914, **8**, 2040.
10. E. P. 13098, 1910, abst. J. S. C. I. 1911, **30**, 407.
11. E. P. 7738, 1914, abst. C. A. 1915, **9**, 2472.
12. H. de Briou, E. P. 3164, 1864. In this connection see review of paint remover patents, Paint, Oil and Drug Rev. 1920, **69**, No. 88, abst. C. A. 1920, **14**, 1226.
13. M. Meyer, D. R. P. 30366, 1884; abst. Wag. Jahr. 1885, **31**, 1140.
14. U. S. P. 488416, 1892; E. P. 14884, 1896, Can. P. 41698, 1893. See also G. Michaelis, U. S. P. 812582.
15. E. P. 2196, 1895; abst. Chem. Ztg. 1896, **20**, 537.
16. F. P. 325659, 1902; J. S. C. I. 1903, **22**, 752.
17. E. P. 22427, 1902. See also C. Nowak, U. S. P. 1038783. Kromofag Vegyeszeti Gyar Szabo es Tarsai, Aust. P. 53207.
18. U. S. P. 725002, 1903; J. S. C. I. 1903, **22**, 563.

employing amyl acetate;¹ and the formula of T. Stoak and W. Peck² and A. Eberson³ appeared the next year. The patented process of S. Sadtler, containing acetone oil⁴ was published in 1907.

Disintegrating Paint Removers. The original paint removers were of a disintegrating nature due to the presence of powerful chemicals contained therein and owed their efficiency to their power of disruption of the paint or varnish pellicle. The acids, as formic,⁵ acetic,⁶ propionic,⁷ butyric,⁸ oxalic,⁹ succinic,¹⁰ tartaric,¹¹ benzoic,¹² lactic,¹³ salicylic,¹⁴ orthophosphoric¹⁵ and nitric,¹⁶ or the hydroxides of sodium,¹⁷ potassium,¹⁸ ammonium,¹⁹ or calcium,²⁰

1. U. S. P. 744095, 1903, E. P. 14974, 1903, abst. J. A. C. S. 1904, **26R**, 276
2. U. S. P. 747898, 1903, abst. J. A. C. S. 1904, **26R**, 325
3. E. P. 18300, 1903, J. S. C. I. 1903, **22**, 1357, F. P. 341832, 1904; C. A. 1911, **5**, 2978
4. S. Sadtler, U. S. P. 871525, 1907, abst. C. A. 1908, **2**, 1060.
5. C. Ellis, U. S. P. 1095270, 1914, C. A. 1914, **8**, 2268
6. J. Dickson, U. S. P. 853685, 1907, C. Ellis, U. S. P. 1147849, C. A. 1915, **9**, 2601, F. Watkins and W. Sreecton, U. S. P. 723089
7. C. Ellis, U. S. P. 1143110, 1915, C. A. 1915, **9**, 2317
8. C. Ellis, U. S. P. 1143111, 1915, C. A. 1915, **9**, 2317
9. C. Ellis, U. S. P. 1100177, 1914, C. A. 1914, **8**, 2816, B. Hansen and Z. Johansen, Norw. P. 20706, 1910, C. A. 1912, **6**, 2012, C. Marohn, U. S. P. 1035620, 1912, C. A. 1912, **6**, 3333, Mon. Sci. 1913, **78**, 108, C. Staley, U. S. P. 673665, 1901.
10. L. Hambrock, U. S. P. 1143386, 1915, C. A. 1915, **9**, 2317.
11. A. Ernst, U. S. P. 576957, 1897
12. C. Ellis, U. S. P. 1049466, 1913, C. A. 1913, **7**, 906, Mon. Sci. 1913, **78**, 108, Chadeloid Chem. Co., U. S. P. 1019467, 1051318, 1051319, 1913, Mon. Sci. 1913, **78**, 108
13. C. Ellis, U. S. P. 997910, C. A. 1911, **5**, 2978
14. S. Jankowski, D. R. P. 254623, 1912; J. S. C. I. 1913, **32**, 244; C. A. 1913, **7**, 1109.
15. G. Feidt, U. S. P. 1119781, 1914, abst. C. A. 1915, **9**, 195.
16. H. Gasser, U. S. P. 242298, 1881, W. Hanna and J. Bryant, U. S. P. 870508, 1907
17. O. Anderson, Swed. P. 42655, 1917, C. A. 1917, **11**, 2722, M. Benedictus, E. P. 10960, 1886, P. Brentini, E. P. 11398, 1888; J. S. C. I. 1889, **8**, 716, F. Casmire, U. S. P. 1230668, 1917, C. A. 1917, **11**, 2283
18. A. Corti, and Chem. Fabrik. Flora A.-G., U. S. P. 784474, 1905, E. P. 21103, 1903, F. P. 335671; Aust. P. 17433, F. Dunnington and M. Hill, U. S. P. 1177938, 1916; C. A. 1916, **9**, 1601, C. Ellis, U. S. P. 1084201, C. A. 1914, **8**, 994, M. Goldstein, U. S. P. 1045785, 1912, C. A. 1913, **7**, 711, J. Halman, E. P. 10797, 1914, C. A. 1915, **9**, 2003, G. Harper, E. P. 14726, 1892, J. Henry, Can. P. 19161, J. Hennich, U. S. P. 1201181; C. A. 1916, **10**, 3169, P. Oates, E. P. 10301, 1888, J. S. C. I. 1889, **8**, 552, R. Pfaffle and G. North, U. S. P. 533666, 1895, A. Pire, E. P. 26284, 1910, F. Posson, U. S. P. 1223518; C. A. 1917, **11**, 1912, Y. Sisler, U. S. P. 453849, 1891, E. Tessen, U. S. P. 521834, 1894, Zonca & Co., E. P. 15140, 1898, J. Humphreys, U. S. P. 1102052; abst. C. A. 1914, **8**, 2959, K. Wessel, U. S. P. 1181361; abst. C. A. 1916, **10**, 1714, L. Haber, U. S. P. 1281156; abst. C. A. 1919, **13**, 78, Q. Marino, E. P. 131709, 1918, abst. C. A. 1920, **14**,

or compounds of calcium,¹ magnesium,² ammonium³ and sodium;⁴ or such carbonates as potassium⁵ and magnesium,⁶ have for many years been employed. Other bodies of similar function, such as ammonium chloride,⁷ ammonium oxalate,⁸ potassium acetate,⁹ borax,¹⁰ calcium sulfide,¹¹ antimonyl chloride (SbOCl),¹² sodium fluoride,¹³ potassium cyanide¹⁴ or carbon bisulfide¹⁵ have received patent protection in the United States and other countries. With paint removers of this nature the wood often was not left in a suitable condition for re-coating.

Solvent Paint Removers. The experiments of C. Ellis and others¹⁶ rendered obsolete the mechanical and destructive removers noted above and they are now being rapidly replaced by a class

252. Cf. Baron de Liebhaver, E. P. 4737, 1886; abst. J. S. C. I. 1887, **6**, 294; preparation of "Tologen" caustic powders for paint removal.

18. O. Enell, U. S. P. 985407, 1911. J. Firth, E. P. 5541, 1902. F. Foster, U. S. P. 328666. E. Geoffroy, E. P. 7258, 1901. C. Hutchins, U. S. P. 1066017, C. A. 1913, **7**, 2837. L. Meyers, Can. P. 23047, 1885. E. Tessen, E. P. 17544, 1894. W. Thomas and A. Jolley, E. P. 24279, 1906.

19. A. Bernard and W. Butler, U. S. P. 608948, 1898. C. Denegre, U. S. P. 1204851; C. A. 1917, **11**, 217. J. Kelly and H. Reid, U. S. P. 1219559; C. A. 1917, **11**, 1758. A. Munder, U. S. P. 271901, 1883. W. Nordaby, U. S. P. 224841, 1880. F. Priestman, U. S. P. 705139, 1902; J. S. C. I. 1902, **31**, 1084. J. Schwemmer, D. R. P. 120882; Wag. Jahr. 1902, **48**, II, 471. H. Slack, E. P. 8934, 1913. H. Stockmeier, Wag. Jahr. 1892, **38**, 1060. A. Ernst, U. S. P. 579957.

20. H. Kearney and J. Harrison, U. S. P. 42295, 1864.

1. O. Catherman, U. S. P. 721150, 1903. P. Hope, U. S. P. 683177, 1901.

2. C. Ellis, U. S. P. 1189804, 1916; C. A. 1916, **10**, 2157.

3. J. Nicles, U. S. P. 1034819, 1912; Mon. Sci. 1913, **78**, 108.

4. C. Beck, U. S. P. 743427, 1903. P. Eliot, E. P. 347673, 1904.

A. Klee, E. P. 14114, 1900.

5. A. Pire, E. P. 26284, 1910; Chem. Ztg. Rep. 1912, **36**, 260.

6. M. Boyd, E. P. 12168, 1908; C. A. 1909, **3**, 960.

7. I. Halman, U. S. P. 1133639; C. A. 1915, **9**, 1398.

8. G. Honeyman, E. P. 3617, 1870.

9. C. Ellis, U. S. P. 925429, 1909.

10. H. d'Harveng, F. P. 402058, 1909; C. A. 1910, **4**, 3146. H. Catlett (U. S. P. 1280162, 1918; abst. J. S. C. I. 1918, **37**, 775-A; C. A. 1918, **12**, 2697) uses trisodium phosphate.

11. C. Bailey, Can. P. 51705.

12. C. Ellis, U. S. P. 876532, 1908; abst. Chem. Ztg. Rep. 1908, **32**, 139.

13. G. Liebhaver, E. P. 4940, 1895; abst. J. S. C. I. 1896, **15**, 207.

14. G. Hull, U. S. P. 897862, 1908; C. A. 1909, **3**, 383.

15. S. Dyson and J. Dyson & Co., E. P. 10311, 1915; C. A. 1917, **11**, 105.

16. For other patents, not specifically mentioned herein, granted to C. Ellis and for the Chadeloid Chemical Co. see U. S. P. 781178, 1005818, 1006737, 1017141, 1082507, 1083007, 1139353, 1146142, 1160394, 1167640, 1167641, 1169783, 1302905. Re-14562. Can. P. 137116, 139024, 139025, 149172, 170942, 189875, 195866, 199020. F. P. 335191. Marschalk, Kunst. 1919, **9**, 35, has published a bibliography of patents on this subject.

of solvent removers which are neutral mixtures of rapid penetration and which not only actually disintegrate and soften the paint or varnish substance without affecting the structure of the wood or metals underneath but possess the additional advantage of containing no water to rust the metal surface or raise the "grain or warp of a glued or veneered exterior."

In order to decrease the volatility of the solvents, various high boiling or non-volatile substances have been added, such as oleic,¹ palmitic,² stearic³ or arichidic acids;⁴ ethyl, methyl⁵ or aluminum⁶ palmitates; or such waxes as Carnauba,⁷ Japan,⁸ Chinese,⁹ bayberry,¹⁰ Candelilla¹¹ or beeswax;¹² cocoa fat,¹³ stearine¹⁴ spermaceti¹⁵ tallow¹⁶ or rosin;¹⁷ sulfonated linseed¹⁸ or castor oil;¹⁹ sodium oleate,²⁰ potassium oleate²¹ aluminum resinate²² or lime soaps;²³ petrolatum,²⁴ ceresine,²⁵ vaseline,²⁶ Venice turpentine,²⁷

- 1 C. Ellis, U. S. P. 1113972, C. A. 1914, **8**, 3811, U. S. P. 1140449, C. A. 1915, **9**, 1849.
- 2 C. Ellis, U. S. P. 1049467, C. A. 1913, **7**, 906, Oil Paint and Drug Reporter 1913, 25. J. Patty, U. S. P. 1019829, 1912.
- 3 I. Kramer, U. S. P. 882947, 1908, abst. C. A. 1908, **2**, 2308.
- 4 C. Reihle and A. Waters, E. P. 27092, 1906, J. S. C. I. 1907, **26**, 1099.
- 5 J. Patty, U. S. P. 1235721, C. A. 1917, **11**, 2736.
- 6 G. Whigelt, U. S. P. 1156119, C. A. 1915, **9**, 3369.
- 7 P. Neymann, U. S. P. 911606, C. A. 1913, **3**, 1097. C. Ellis, U. S. P. 1147848, C. A. 1915, **9**, 2601.
- 8 C. Ellis, U. S. P. 714880, 1902, J. S. C. I. 1903, **22**, 36. U. S. P. 876304, 900687, abst. Kunst 1911, **1**, 413.
- 9 C. Ellis, U. S. P. 956320, C. A. 1910, **4**, 1689.
- 10 C. Ellis, U. S. P. 985406, 1911, abst. C. A. 1911, **5**, 1527.
- 11 H. Harris, U. S. P. 1145365; C. A. 1915, **9**, 2459. J. Wilson and H. Harris, U. S. P. 1046926, 1912, Mon. Sci. 1913, **78**, 108. E. P. 4161, 1912, J. S. C. I. 1913, **32**, 372.
- 12 J. Wilson, F. P. 390422, 1908, J. Wilson and H. Harris, F. P. 390327, 1908, abst. Mon. Sci. 1910, **73**, 107.
- 13 S. Kaufman, E. P. 14708, 1913, C. A. 1915, **9**, 125; D. R. P. 265059, 1912, C. A. 1914, **8**, 555.
- 14 J. Manns, E. P. 4592, 1909; J. S. C. I. 1909, **28**, 895.
- 15 T. Devine, U. S. P. 1024926, 1912; abst. C. A. 1912, **6**, 1686.
- 16 A. Neidhardt, U. S. P. 816359, 1906, abst. J. A. C. S. 1906, **28R**, 476.
- 17 G. Moore, U. S. P. 338544, 1896.
- 18 C. Ellis, U. S. P. 904250, 1908; 1000966, C. A. 1911, **5**, 3736.
- 19 C. Ellis, U. S. P. 907758; C. A. 1909, **3**, 960.
- 20 C. Ellis, U. S. P. 1147851; C. A. 1915, **9**, 2601.
- 21 C. Ellis, U. S. P. 1000162; C. A. 1911, **5**, 3736.
- 22 C. Ellis, U. S. P. 910049, 1909, C. A. 1909, **3**, 1096.
- 23 J. Manns, E. P. 4592, 1910, J. S. C. I. 1911, **30**, 201.
- 24 Adams & Elting Co., E. P. 16060, 1903; J. S. C. I. 1903, **22**, 1090.
- 25 J. Alexander, U. S. P. 1051978, C. A. 1913, **7**, 1108. DeRonda Osborn Co., Can. P. 84598, 1903; Belg. P. 171434, 1903. G. Dossilman and P. Neymann, U. S. P. 907685, 1908; U. S. P. 1113964, 1914; C. A. 1914, **8**, 3806. C. Ellis, U. S. P. 1229247, 1917; Can. P. 78586. P. Geller, U. S. P. 951369, 1910.

naphthalene¹ and waxes² have also been employed for this purpose.

Inorganic combinations, as alum,³ calcium⁴ and ammonium⁵ acetates, sodium benzoate,⁶ chlorinated glycerol,⁷ glucose,⁸ camphor oil,⁹ fish oil¹⁰ cresols¹¹ amyl tartarate¹² cumene,¹³ ethyl citrate,¹⁴ chloranilin¹⁵ and camphor oil¹⁶ are examples of substantially non-volatile bodies inhibiting evaporation which have received patent protection.

The majority of the above named constituents, while decreasing the volatility of the lower boiling solvent portion of the paint and varnish remover composition exert little or but feeble solvent powers. The present tendency, therefore, is to combine, where possible, high boiling liquids which at the same time are fluids of paint and varnish dissolving powers. Among these are the higher ketones,¹⁷ as heptylketone, butyrones,¹⁸ allyl alcohol,¹⁹ phenol²⁰ and sodium phenolate;²¹ benzaldehyde,²² benzyl

- G. Michaelis, U. S. P. 823801, 1906 R. Stewart, U. S. P. 931519, 1909; C. A. 1909, **3**, 2632 J. Wilson and H. Harris, U. S. P. 890479, 1908
25. M. Daxe, U. S. P. 948814, 1910 G. Dossilman and P. Neymann, U. S. P. 1014211, 1912 C. Ellis, U. S. P. 901895, 1908
26. Detroit White Lead Works, Can. P. 117579, 1908
27. A. Hoover, U. S. P. 902404, 1908, abst. C. A. 1909, **3**, 596
1. M. Toch, U. S. P. 871195, 1907, abst. C. A. 1908, **2**, 1060.
2. C. Ellis, U. S. P. 817141, 1906, J. S. C. I. 906, **25**, 434, 1229247; C. A. 1917, **11**, 2283. E. P. 28236, 1902, 3412, 1906, D. R. P. 150881, abst. Wag. Jahr 1904, **50**, II, 501
3. J. Dickson, U. S. P. 871790, 1907
4. C. Ellis, U. S. P. 1113970; C. A. 1914, **8**, 3866 U. S. P. 1118482; C. A. 1915, **9**, 158 C. Schroeder, U. S. P. 1016445, 1912
5. A. Olim, U. S. P. 1116614, C. A. 1915, **9**, 129.
6. C. Ellis, U. S. P. 1172772, C. A. 1916, **10**, 1104
7. C. Ellis, U. S. P. 1146854, C. A. 1915, **9**, 2459
8. W. Alexander, U. S. P. 1143878, C. A. 1915, **9**, 2318.
9. C. Ellis, U. S. P. 1145980, C. A. 1915, **9**, 2459.
10. W. Stuhlmiller, U. S. P. 885396, 1908.
11. Siderosthen Paint Syndicate, Can. P. 61694, 1898.
12. C. Ellis, U. S. P. 985404, 1911, abst. C. A. 1911, **5**, 1527.
13. C. Ellis, U. S. P. 1146854; C. A. 1915, **9**, 2459.
14. C. Ellis, U. S. P. 985405, 1911, abst. C. A. 1911, **5**, 1527.
15. S. Schwimmer, E. P. 10497, 1914, C. A. 1915, **9**, 2819.
16. H. Blackmore, U. S. P. 1184164, 1916; C. A. 1916, **11**, 1797. C. Ellis, U. S. P. 1145980, 1915; C. A. 1915, **9**, 2459.
17. Chadeloid Chem. Co., Can. P. 105213, 1907.
18. C. Ellis, U. S. P. 994139, 1911; abst. C. A. 1911, **5**, 2572.
19. C. Ellis, U. S. P. 1051318; C. A. 1913, **7**, 907; U. S. P. 1069057; C. A. 1913, **7**, 3241.
20. J. Wilson, U. S. P. 1036946, 1912; Farben. Ztg. 1912, **17**, 2815; Mon. Sci. 1913, **78**, 108; U. S. P. 1046926; Mon. Sci. 1913, **78**, 108. Can. P. 126816, 1910. G. McAdam and The Chadeloid Co., U. S. P. 1274430,

alcohol,¹ benzyl benzoate,² benzyl cresylate³ and hexahydrobenzene;⁴ dimethylphthalate,⁵ terpineol,⁶ chlorobenzene,⁷ aniline⁸ and oil of cloves⁹ are examples.

Methylamine,¹⁰ Chinese wood oil,¹¹ oxycellulose¹² and alkali palmitates¹³ appear of doubtful value. Among the low boiling solvents that have been found especially energetic are methyl acetate¹⁴ and methyl acetone¹⁵ either alone or combined with carbon tetrachloride¹⁶ to reduce inflammability.

Where the paint removing mixture is high in cellulose ester solvents, nitrocellulose¹⁷ or celluloid¹⁸ make excellent solvent

1918, abst. J. S. C. I. 1918, **37**, 663-A, C. A. 1918, **12**, 2056. C. Ellis, U. S. P. 1328080, abst. C. A. 1920, **14**, 851. The Chadeloid Co., Can. P. 199209, 1920.

21. C. Ellis, U. S. P. 983884, 1911, abst. C. A. 1911, **5**, 1526. J. Patty, U. S. P. 982524, 1911.

22. C. Ellis, U. S. P. 1051319, 1913, Mon. Sci. 1913, **79**, 108, C. A. 1913, **7**, 907; U. S. P. 1066720, 1913, C. A. 1913, **7**, 3037.

1. C. Ellis, U. S. P. 1118642, 1914, C. A. 1915, **9**, 150. U. S. P. 1306221, 1919, abst. J. S. C. I. 1919, **38**, 590-A, C. A. 1919, **13**, 2140. Can. P. 195866, 1920, abst. C. A. 1920, **14**, 642. Can. P. 199057, 1920.

2. Akt. Ges. Anilin Fabrikation, B. P. 17523, 17531, 1913.

3. C. Ellis, U. S. P. 1185641, 1916, C. A. 1916, **10**, 2049.

4. C. Ellis, U. S. P. 1006388, 1911, C. A. 1911, **5**, 3736.

5. C. Ellis, U. S. P. 1130499, C. A. 1915, **9**, 1126.

6. C. Ellis, U. S. P. 1147852, 1915, C. A. 1915, **9**, 2601.

7. C. Ellis, U. S. P. 1118482, 1914, C. A. 1915, **9**, 158.

8. C. Ellis, U. S. P. 1189803, 1916, C. A. 1916, **11**, 2157. L. Ornstem, U. S. P. 931335, 1909, C. A. 1909, **3**, 2632.

9. M. Rubini, E. P. 14787, 1911, C. A. 1913, **7**, 278, D. R. P. 238382, 1910, C. A. 1912, **6**, 1687. In this connection see also Ronde Osborne Co., F. P. 333652. Adams & Elting Co., F. P. 335191. A. Ebersson, F. P. 341832. P. Elliot, F. P. 347673. H. Andersen, F. P. 367853. J. Vaysse, F. P. 368616. Esteve & Cie, F. P. 378991. R. Marsat and M. Pourcheiroux, F. P. 402051. H. d'Harveng, F. P. 402058.

10. C. Ellis, U. S. P. 1113971, 1914, C. A. 1914, **8**, 3806.

11. H. Gardner, U. S. P. 1079698, 1914, C. A. 1914, **8**, 432.

12. The Wilson Co., Can. P. 108705, 1907. J. Wilson and H. Harris, E. P. 10043, 1908; J. S. C. I. 1909, **28**, 663.

13. J. Patty, U. S. P. 1235721, 1917, J. S. C. I. 1917, **36**, 1019. C. Ellis, U. S. P. 875416.

14. H. Blackmore, U. S. P. 1184164, 1916, J. S. C. I. 1916, **35**, 717. C. Ellis, U. S. P. 979136, 1910.

15. C. Ellis, U. S. P. 811044, 1906, 1014752, 1027466, 1912.

16. Chadeloid Chem. Co., Can. P. 105214, 1907. C. Ellis, U. S. P. 817141, 1906; J. S. C. I. 1906, **25**, 434; Mon. Sci. 1907, **67**, 57. E. P. 3413, 1906, J. S. C. I. 1907, **26**, 159; F. P. 363506, 1906, J. S. C. I. 1906, **25**, 857.

17. H. Chalmers, U. S. P. 1066251, 1913, C. A. 1913, **7**, 2864, U. S. P. 1079635, 1914; C. A. 1914, **8**, 432. C. Ellis, U. S. P. 919143, C. A. 1909, **3**, 1818, U. S. P. 1147850, 1915, C. A. 1915, **9**, 2601. U. S. P. 1172773, 1916, C. A. 1916, **11**, 1104. J. Wilson, U. S. P. 1074305, 1913, C. A. 1913, **7**, 3849. J. Wilson and C. Forrest, U. S. P. 1129770, C. A. 1916, **11**, 1126, U. S. P. 1173628,

inhibitors,¹ usually in conjunction with the lower boiling fluids.

Of the mechanical contrivances for the use of these solvent removers the methods and apparatus of J. Wilson,² C. Ellis,³ C. Fess⁴ and A. Gottschalk⁵ may be mentioned. As non-evaporative solvent inhibiting bodies certain colloids as casein,⁶ ammonium caseinate,⁷ gelatine⁸ and similar bodies⁹ have been used with considerable success.

Turpentine Substitutes. The solvents for dissolving nitro-cellulose have for many years been used in the manufacture of substitutes for turpentine. The earlier processes of J. Rimell,¹⁰ W. Perkin,¹¹ L. Reisberger,¹² L. Bisco,¹³ and G. Dilette and J. Talabot,¹⁴ and the more modern formulae of A. Poulverel,¹⁵ E. Pladet,¹⁶ O. Pellnitz,¹⁷ A. Pollet,¹⁸ R. Valette,¹⁹ and A. Hesse²⁰ used

C. A. 1916, **11**, 1104.

18. C. Ellis, U. S. P. 1118642, 1915; C. A. 1915, **9**, 158. U. S. P. 1051317, C. A. 1913, **7**, 907.

1. Chadeloid Chem. Co. vs. De Ronde, 146 Fed. Rep. 988.

2. J. Wilson, U. S. P. 872314, 1907; 936842, 1909; 986531, 1911; E. P. 10044, 1908; Can. P. 113142, 1908, 123118, 1910.

3. C. Ellis, U. S. P. 875163, 1907. U. S. P. 1185641, 1916, J. S. C. I. 1916, **27**, 853.

4. C. Fess, U. S. P. 872561, 1907, 945505, 1910. J. Lostumbo and A. Olander, U. S. P. 1279888, 1918, abst. C. A. 1918, **12**, 2697.

5. A. Gottschalk, E. P. 8617, 1905; D. R. P. 158310, 1904; J. S. C. I. 1905, **24**, 681. D. R. P. 281758, 1913, abst. C. A. 1915, **9**, 2320.

6. F. Govers, U. S. P. 868920, 1907. C. Ellis, U. S. P. 1069056, 1913, C. A. 1913, **7**, 3241.

7. P. Austen and F. Maywald, U. S. P. 846080, 1907, J. S. C. I. 1907, **26**, 477; E. P. 5238, 1907; J. S. C. I. 1908, **27**, 345.

8. C. Ellis, U. S. P. 1102330, 1914; C. A. 1914, **8**, 2959.

9. W. Allen and W. Weaver, U. S. P. 876251, 1908. P. Austen and F. Maywald, and F. Govers, U. S. P. 871750, 1907. E. Compton, E. P. 11428, 1885. F. Govers, U. S. P. 869176, 1907; U. S. P. 885151, 1908. J. S. C. I. 1908, **27**, 579. F. Govers, F. Maywald, and E. Austen, Can. P. 122150, 122151, 1909. F. Maywald, F. Govers and E. Austen, Can. P. 122152, 122153, 122154, 1909. F. Maywald and E. Austen, Can. P. 122149, 1909. A. Nienstadt, U. S. P. 1143130, 1915, C. A. 1915, **9**, 2317. G. Willock, E. P. 16930, 1901. P. Ryan, U. S. P. 878240.

10. E. P. 607, 1855.

11. E. P. 3410, 1863.

12. D. R. P. 53936; abst. Wag. Jahr. 1890, **36**, 1171.

13. Belg. P. 148550, 1900; Aust. P. 6673, 1901. See Am. J. Pub. Health, **8**, 736; abst. C. A. 1919, **13**, 78.

14. F. P. 341927, 1904. See also F. P. 341158, 1904; abst. J. S. C. I. 1904, **23**, 885.

15. F. P. 400180, 1908; abst. Mon. Sci. 1910, **73**, 103.

16. Belg. P. 213364, 1909.

17. D. R. P. 202254, 1907; abst. J. S. C. I. 1908, **27**, 1212, C. A. 1909, **3**, 494. D. R. P. 218337, 1908, Addn. to D. R. P. 202254, 1907; abst. C. A. 1912, **6**, 1814; Zts. ang. Chem. 1910, **23**, 383; Chem. Zentr. 1910, **31**, I, 705;

copal,¹ purified petroleum distillates,² heavy benzenes and cyclic hydrocarbons,³ pine oil,⁴ rosin spirit,⁵ and similar bodies for this purpose. The researches of J. Marcusson,⁶ H. Herzfeld,⁷ V. Gamet,⁸ A. Matthis,⁹ S. Ijubovski,¹⁰ L. Andes,¹¹ A. Paul,¹² M. Bottler,¹³ L. Hawley¹⁴ and other investigators¹⁵ have greatly

Chem. Ztg. Rep. 1910, **34**, 114; Chem. Ind. 1910, **33**, 126; Wag. Jahr. 1910, **56**, II, 584. F. P. 394467, 1908. Addn. dated Dec. 8, 1908 to F. P. 394467, 1908. Zts. ang. Chem. 1908, **21**, 2380; Chem. Zentr. 1908, **79**, II, 1309. Chem. Ztg. Rep. 1908, **32**, 618; Chem. Ind. 1908, **31**, 653; Wag. Jahr. 1908, **54**, II, 101. E. P. 19833, 27024, 1908; abst. C. A. 1909, **3**, 2243, 3013.

18. F. P. 354425, 1905; abst. J. S. C. I. 1905, **24**, 1118. Addn. 6170, 1906 to F. P. 354425, 1905. Belg. P. 185616, 191981, 1906.

19. F. P. 415218, 1909; abst. J. S. C. I. 1910, **29**, 1321.

20. E. P. 7934, 1906; abst. J. S. C. I. 1906, **25**, 1161. F. P. 374164, abst. J. S. C. I. 1907, **26**, 778.

1. W. Vaubel, Zts. ang. Chem. 1910, **23**, 1165; abst. J. S. C. I. 1910, **29**, 890.

2. W. Earles, H. Robertson, F. Mote and T. Cartwright, E. P. 19927, 1911; abst. J. S. C. I. 1912, **31**, 998; C. A. 1913, **7**, 907. W. Whitney and C. Griffin, U. S. P. 969432, 1910 (use of Texene). R. Bone, U. S. P. 1343387; abst. C. A. 1920, **14**, 2416.

3. A. Merbig, Farben. Ztg. **16**, 1643; abst. C. A. 1912, **6**, 1363; Chem. Zentr. 1911, **82**, II, 650. Farben. Ztg. **16**, 2739; abst. C. A. 1912, **6**, 2691. M. Darrin, U. S. P. 1340600; abst. C. A. 1920, **14**, 2095. For the use of tetra- and decahydronaphthalene ("tetralin" and "dekalin") see Vollman, Farben. Ztg. 1919, **24**, 1689; abst. C. A. 1920, **14**, 357. H. Smit—Addens, Ölen en Vetten, 1920, No. 28, 353; abst. C. A. 1920, **14**, 1227.

4. J. Marcusson, Chem. Ztg. 1909, **33**, 966, 978, 985; abst. J. S. C. I. See also O. Sprenger, Belg. P. 210591, 212477, 1908. Chem. Werke Furstenwalde, B. Hecker and W. Zeidler, D. R. P. 196907, 1906; abst. J. S. C. I. 1908, **27**, 579; Zts. ang. Chem. 1908, **21**, 1375; Chem. Zentr. 1908, **79**, I, 1594; Chem. Ztg. Rep. 1908, **32**, 232; Chem. Ind. 1908, **31**, 272.

5. Mühle, Farben. Ztg. **16**, 1098, 1812; abst. Chem. Zentr. 1911, **82**, II, 649, 650. C. A. 1912, **6**, 1363. See also Paffgen & Schwartz, Belg. P. 226740, 1910.

6. J. Marcusson, Chem. Ztg. 1909, **33**, 966, 978, abst. C. A. 1910, **4**, 1236.

7. Chem. Ztg. 1910, **34**, 885, abst. C. A. 1910, **4**, 1665.

8. Mat. grasses, **3**, 1993; abst. C. A. 1911, **5**, 1677.

9. Bull. etudiants inst. Meurice **1**, 143; abst. Bull. Soc. Chim. Belg. **26**, 466; C. A. 1913, **7**, 1622.

10. Seifenseider. Ztg. 1914, **41**, 934, 963, 977, 1013, abst. C. A. 1915, **9**, 157.

11. Rev. Fett. Harz. Ind. **16**, 248; abst. C. A. 1909, **3**, 3009.

1. J. Ind. Eng. Chem. 1909, **1**, 27; abst. C. A. 1909, **3**, 712, 2375.

13. Rev. Fett. Harz. Ind. **17**, 73, 102; abst. C. A. 1910, **4**, 1908; Rev. Fett. Harz. Ind. **19**, 49, 72, 99, 125, 153, 178; abst. C. A. 1912, **6**, 3025. Kunst. 1912, **2**, 25; abst. C. A. 1912, **6**, 2544. Chem. Ind. 1913, **36**, 522; abst. C. A. 1914, **8**, 584. See also L. Andes, Farb. Ztg. **17**, 1095. F. Veitch and M. Donk, Farb. Ztg. **17**, 1440.

14. Orig. Com. 8th Int. Cong. Appl. Chem. 1912, **12**, 41; abst. C. A. 1912, **6**, 3023.

15. J. Coste and L. Nash, Analyst 1911, **36**, 207; abst. J. S. C. I. The Cadillac Turpentine Co. Pulp and Paper Mag. of Canada **6**, 267; abst. J. S. C. I. 1909, **28**, 835. F. Pope, U. S. P. 982631, 1911; abst. J. S. C. I. 1911,

extended our recent knowledge of this branch of the subject.¹

Inasmuch as these substitute combinations are always less expensive and in general less suitable than natural turpentine, much ingenuity has been expended in the elaboration of simple and accurate analytical methods for the detection and estimation of these substitutes. The methods as devised by R. Adan,² C. Bakker,³ W. Burton,⁴ J. Coste,⁵ A. Eibner and O. Hue,⁶ K. Enz,⁷ H. Frey,⁸ C. Grimaldi,⁹ J. Marcusson,¹⁰ F. Klein,¹¹ J. McCandless,¹² R. Massey,¹³ Mänsier,¹⁴ R. Marcille,¹⁵ L. Mennechet,¹⁶ R. Morrell,¹⁷ P. Nicolardot and L. Clement,¹⁸ A. Paul,¹⁹ C. Piest,²⁰

30, 295 Anon Farb Ztg 1915, **20**, 715, abst C A 1915, **9**, 1848 Chem Trade J. Feb 4, 1911; abst J S C. I. For processes of de-odorizing turpentine substitutes, etc., see E. Heber, E. P. 10004, 1903 Anon Ann. Fals. 1917, **33** F. Marre, Gene Civil 1905, **47**, 265 M. Bottler, Chim Ind 1913, 522

¹ F. Grossmann, Farbe u. Lack, 1919, 131, 143, 151, 193; abst. Chem. Zentr. 1920, **91**, II, 131, 376

² Bull. soc. chim. Belg. 1908, **22**, 389, abst J S C. I. 1908, **27**, 1122, C. A. 1909, **3**, 382 See also H. Herzfeld, Z. öffentl. Chem. 1903, **9**, 454, J S C. I. 1904, **23**, 274

³ Chem. Weekblad, **10**, 120, abst C A 1913, **7**, 3223

⁴ Analyst, 1890, **15**, 105, abst. Amer. Chem. J. 1890, **12**, 102, Wag. Jahr 1890, **36**, 735

⁵ Analyst, 1909, **34**, 148, 1910, **35**, 112, abst J S C. I. 1909, **28**, 482, 1910, **29**, 438

⁶ Chem. Ztg. 1910, **34**, 643, 657, abst C. A. 1910, **4**, 3134

⁷ Apoth. Ztg. 1914, **29**, 785, 797, abst C. A. 1914, **8**, 951

⁸ J. A. C. S. 1908, **30**, 420, See also H. Shrewsbury, Analyst, 1911, **36**, 137; abst. C. A. 1911, **5**, 2173

⁹ Chem. Ztg. 1911, **35**, 52, abst J S C. I. 1911, **30**, 141. See also J. S. C. I. 1910, **29**, 963 C. Grimaldi and L. Prussia, Chem. Ztg. 1913, **37**, 657, 1123; abst C. A. 1914, **8**, 1677 Annali. Chem. Appl. 1914, **1**, 324; abst. J. S. C. I. 1914, **33**, 604 Chem. Ztg. 1914, **38**, 1001; abst. C. A. 1915, **9**, 248 See also C. A. 1914, **8**, 2814

¹⁰ Chem. Ztg. 1909, **33**, 285, 966, 978, abst C. A. 1910, **4**, 1236 Chem. Ztg. 1912, **36**, 413, 421, abst. J. S. C. I. 1912, **31**, 444, C. A. 1912, **6**, 2521; Wag. Jahr 1912, **58**, II, 302 Mitt. Kgl. Materialprüfungsamt, **31**, 155, abst C. A. 1914, **8**, 1664 Chem. Rev. Fett Harz. Ind. **17**, 6, abst C. A. 1910, **4**, 1541. See also G. Fendler, L. Frank and W. Struber, Zts. Nahr. Genussm. **13**, 373, abst. C. A. 1910, **4**, 1803

¹¹ J. Ind. Eng. Chem. 1910, **2**, 389, abst. J S C. I. 1910, **29**, 1214.

¹² J. A. C. S. 1904, **26**, 981; abst J S C. I. 1904, **23**, 913.

¹³ J. pharm. chim. 1912, **6**, 484, abst J. S. C. I. 1913, **22**, 34.

¹⁴ Ann. Chim. analyt. 1909, **14**, 417, abst. J S C. I. 1909, **28**, 1260. Rept. pharm. (3), **21**, 434; abst. C. A. 1910, **4**, 950.

¹⁵ Ann. Fals. **5**, 241; abst. Bull. Soc. Chim. 1912, **11**, 762, C. A. 1912, **6**, 2685; J. S. C. I. 1912, **31**, 783.

¹⁶ Bull. Fed. der Pharmaciens Sud. Ouest et Centre. Jan. 1911, abst. Rept. pharm. (3), **23**, 209, C. A. 1911, **5**, 2977.

¹⁷ J. S. C. I. 1910, **29**, 241, abst C. A. 1910, **4**, 1664.

¹⁸ Compt. Rend. 1909, **149**, 572; abst. Bull. Soc. Chim. 1910, **7**, 105;

F. Richardson and J. Whitaker,¹ P. van der Wielen,² have to do primarily with methods for the estimation of benzene and petroleum residues. Alcohol,³ rosin,⁴ varnish spirits,⁵ solvent naphtha,⁶ and "first runnings,"⁷ are not infrequently found. Determination of the refractive index,⁸ rotatory power,⁹ acetic acid solvent power,¹⁰ miscibility curves,¹¹ and bromine absorption,¹² have been found useful in certain instances. Additional methods have been proposed by C. Blarez,¹³ M. Bottler,¹⁴ N. Chercheffsky,¹⁵ L. Clement,¹⁶ G. Frankforter,¹⁷ W. Geer,¹⁸ A. Haemmelmann,¹⁹

J. S. C. I. 1909, **28**, 1147, C. A. 1910, **4**, 1541. Bull. Soc. Chim. 1910, **7**, 173.

19. J. Ind. Eng. Chem. 1909, **1**, 261, abstr. C. A. 1909, **3**, 2375.

20. Chem. Ztg. 1912, **36**, 198, abstr. J. S. C. I. 1912, **31**, 239, C. A. 1912, **6**, 1373.

1. J. S. C. I. 1911, **30**, 115, abstr. C. A. 1911, **5**, 2137. See also H. Armstrong, J. S. C. I. 1882, **1**, 478. F. Richardson and J. Bowen, J. S. C. I. 1908, **27**, 613, abstr. C. A. 1908, **2**, 2872.

2. Pharm. Weekblad, 1911, No. 35, abstr. Perfumery and Essential Oil Rec. 1911, **2**, 256, J. S. C. I. 1911, **30**, 1396, C. A. 1912, **6**, 1816. Pharm. Weekblad 1911, **48**, 1026, abstr. C. A. 1911, **5**, 3719.

3. R. Massy, Rev. chim. ind. **22**, 285, abstr. C. A. 1912, **6**, 302.

4. H. Delfour, Bull. des Travaux, Soc. Pharm. Bordeaux, 1911, 373, abstr. Bull. de Commerce, 1911, **39**, 561, J. S. C. I. 1912, **31**, 33.

5. D. Holde, Chem. Ztg. 1913, **37**, 610, abstr. J. S. C. I. 1913, **32**, 589.

6. A. Krieger, Chem. Ztg. 1916, **40**, 172, abstr. J. S. C. I. 1916, **35**, 746, C. A. 1916, **10**, 2646. See also H. Herzfeld, Z. Offent. Chem. 1903, **9**, 454.

7. H. Wolff, Farbenztg. 1912, **17**, 1492, abstr. Chem. Zentr. 1912, **83**, I, 1930, J. S. C. I. 1912, **31**, 692, C. A. 1912, **6**, 3193. Farben Ztg. **17**, 1553, abstr. C. A. 1912, **6**, 3189. Pharm. Ztg. **58**, 288, abstr. C. A. 1913, **7**, 288.

8. Utz Chem. Rev. Fett u. Harz Ind. 1905, **12**, 99, abstr. J. S. C. I. 1905, **24**, 562.

9. I. Raby, Ann. Chim. anal. appl. 1905, **10**, 146, abstr. Chem. Centr. 1905, **76**, I, 1471, J. S. C. I. 1905, **24**, 682.

10. P. Squire and C. Canes, Pharm. J. 1902, **68** (1668), 512, abstr. J. S. C. I. 1902, **21**, 929.

11. M. Vezes, Compt. rend. 1909, **150**, 698, abstr. C. A. 1910, **4**, 1665, 3143. See also E. Louise, Compt. rend. 1909, **150**, 526, abstr. C. A. 1909, **3**, 2781. H. Herzfeld, Chem. Ztg. 1909, **33**, 1081, abstr. C. A. 1910, **4**, 1665. J. Marcusson, C. A. 1910, **4**, 1236, 1541.

12. W. Vaubel, Pharm. Ztg. 1906, 257, abstr. Wag. Jahr. 1906, **52**, II, 126.

13. Ann. Chim. analyt. 1911, **16**, 328, abstr. C. A. 1912, **6**, 302. For temperature of miscibility with aniline see also J. S. C. I. 1907, **26**, 932, 1909, **28**, 892, 1910, **29**, 438, 501.

14. Chem. Rev. Fett. Harz Ind. **18**, 108, 131, 166, 185, 214, 242, 267, 288, abstr. C. A. 1912, **6**, 1372.

15. Mat. Grasses 1910, **5**, 29, 2843, 2878, 2908, 2940, abstr. C. A. 1913, **7**, 1106.

16. Mat. Grasses, **2**, 1565, **3**, 1670; abstr. C. A. 1910, **4**, 106.

17. J. A. C. S. 1906, **28**, 1467, abstr. J. S. C. I. 1906, **25**, 1107.

18. U. S. Dept. Agri. Forest Serv. Circ. 152; abstr. C. A. 1909, **3**, 382.

19. Chem. Ztg. 1913, **37**, 1123, abstr. C. A. 1914, **8**, 1677.

H. Herzfeld,¹ C. Holley,² E. Louise,³ S. Suentola,⁴ F. Utz,⁵ Veitch and M. Donk,⁶ M. Vezes,⁷ W. Witt⁸ and others⁹ containing relatively unimportant modifications.

Cellulose Nitrate Lacquers, Varnishes and Bronzing Liquids.

The development of the art of protecting surfaces by the application thereto of some form of nitrocellulose in solution, had its first inception in the "ether glue" and "sticking plaster" of the pharmacists, and the "collodion combinations" of the earlier photographers, these two arts gradually converging during the latter half of the past century into the present industry of modern pyroxylin lacquers.

The subject matter of this Section Two (see p. 2380) and included in pp. 2572-2599, consists of the following topics:

1. Collodion lacquers, and the earlier attempts to utilize fluid nitrocellulose combinations (2573-2577).
2. Celluloid lacquers, where one constituent was present inducing thermoplasticity (2577-2581).
3. Amyl acetate pyroxylin lacquers (2581-2585).
4. Bronzing liquids, gold paints (2585-2586).
5. Imitation gold leaf of nitrocellulose and bronze; Oriental tissue (2586-2588).
6. Mother-of-Pearl; nitrocellulose nacreous combinations (2588-2590).
7. Pyroxylin-resin lacquers; gums, resins and oleoresins with

1. Zts. Offentl. Chem. 1904, **10**, 382; abst. Chem. Centr. 1904, **75**, II, 1770; J. S. C. I. 1905, **24**, 108.

2. 17th Ann. Rep. N. Dak. Agr. Exp. Sta. pt. II, 1906; abst. C. A. 1907, **1**, 486.

3. Compt. rend. 1910, **150**, 526; abst. J. S. C. I. 1910, **29**, 438.

4. Pharm. Zentralhalle, **55**, 2; abst. C. A. 1914, **8**, 985.

5. Chem. Rev. 1906, 162, 399; Farben. Ztg. 1912, **17**, 1208; Zts. Unters. Nahr. Genussm. 1914, **27**, 687; abst. J. S. C. I. 1914, **33**, 1099. See also R. Boehme Chem. Ztg. 1906, 633.

6. U. S. Dept. Agri. Bur. Chem. Bull. **135**, abst. C. A. 1912, **6**, 2522.

7. Bull. Soc. Chim. 1903, **29**, (16), 896; abst. J. S. C. I. 1903, **22**, 1106.

8. Farben. Ztg. **14**, 47; abst. Rev. Fett. Harz. Ind. **16**, 253; abst. C. A. 1909, **3**, 3009.

9. Semi-Ann. Rep. Schimmel, 1910, 109. Bull. 253, Inland Rev. Dept. Ottawa, 1028, abst. J. S. C. I. 1913, **22**, 1028. Year Book. Am. Soc. Testing Materials, 1915, 428; abst. C. A. 1916, **10**, 975. See also C. A. 1914, **8**, 3503. N. Chereffsky, Mat. Grass. 1910, 18. E. Coen, Annali Lab. Chim. Centr. delle Gabelle, 1914, **7**, 99; Annali Chim. Appl. 1915, **3**, 372; abst. J. S. C. I. 1915, **34**, 841. J. Taus, Chem. Ztg. 1918, **42**, 349; abst. J. S. C. I. 1918, **37**, 554-A. J. Coste and L. Nash, Analyst, 1911, **36**, 207; abst. C. A. 1911, **5**, 2426.

cellulose nitrate; brush lacquers; staining of wood (2590-2594).

8. Nitrocellulose Electric Light Filaments (2594). For other artificial filaments, see pp. 2621-2655.

9. Nitrocellulose incandescent gas mantles (2595-2597).

10. Nitrocellulose applications in the electrical industries (2597-2598).

11. Solid alcohol; travelers spirits; portable alcohol with pyroxylin (2598-2599).

12. Other applications of the cellulose nitrate lacquers (2599-2600).

Collodion Lacquers. The earlier combinations of this nature embraced the solution of cellulose nitrate in volatile and hygroscopic solvents—the only fluids known for this purpose at that time—being mainly mixtures of ether and ethyl alcohol. The mirror silvering composition of H. Vohl,¹ and the collodion combinations of L. Cornides,² S. Barnwell and A. Rollason,³ K. Cheetham and T. Southworth,⁴ A. Parkes,⁵ M. Pellen,⁶ H. Hoffman,⁷ J. Macintosh,⁸ P. Berard,⁹ and J. Childs¹⁰ were all described and patented before 1860. The silk lustering composition of R. Hands,¹¹ size of J. Thiebaut,¹² flexible collodion of G. Gerard,¹³ wire coating mixture of T. Morris, R. Weare and E. Monckton,¹⁴ and the cartridge waterproofing composition of A. Johnston and L. Dow,¹⁵ all contained cellulose nitrate dissolved in ether-alcohol. The uses of these protective coverings was necessarily limited, due to the rapidity of evaporation of the solvent portion, as is indicated in the writings of F. Luchs,¹⁶ A. Sax,¹⁷ Bernhard,¹⁸ A.

1. *Technologist*, April, 1849; abst. *Dingl. Poly.* 1849, **112**, 237; *Chem. Centr.* 1849, **20**, 445; *Jahr. Chem.* 1849, **2**, 473.

2. E. P. 2637, 1854.

3. E. P. 945, 1859. E. P. 2249, 1860. See also *Mon. Sci.* 1862, **4**, 30.

4. E. P. 653, 1857.

5. E. P. 1366, 1868. E. P. 2359, 1855.

6. E. P. 2250, 1856.

7. U. S. 18838, 1857.

8. E. P. 1090, 1858.

9. E. P. 1883, 1884, 1857; 639, 1858; abst. *Poly. Centr.* 1858, **21**, 892; 1859, **25**, 413. F. P. 35368, 1858, *Wag. Jahr.* 1868, **14**, 358, *Mon. Sci.* 1868, **10**, 1041.

10. E. P. 2295, 1859.

11. E. P. 2417, 1860.

12. E. P. 1721, 1860.

13. F. P. 44902, 1860.

14. E. P. 2661, 1861.

15. U. S. P. 35687, 1862.

16. *Dingl. Poly.* 1862, **166**, 62; abst. *Chem. Centr.* 1862, **33**, No. 58;

Rollason,¹ H. de Briou,² L. Simonet,³ F. Buttin,⁴ Strolberger,⁵ Despaquis,⁶ and W. Grue.⁷ Paraffin,⁸ benzine,⁹ turpentine,¹⁰ boric acid¹¹ and shellac¹² are some of the adjuncts tried before 1870 to lessen the distortion and increase the adhesiveness of the collodion film.

Collodion lacquers have been employed as fuse strips,¹³ coating wood,¹⁴ for waterproofing compounds¹⁵ and preserving metal work,¹⁶ as varnish for the base of artificial teeth,¹⁷ telegraph cables,¹⁸ fabrics,¹⁹ artificial flower manufacture,²⁰ and preservation of vegetable parchments,²¹ together with the methods of tipping cigars with collodion of J. Harris²² and L. von Babo,²³ and the processes of R. Winter,²⁴ F. Springmuhl,²⁵ Persoz,²⁶ and v. Monck-

Poly. Centr. 1863, **29**, 270 Chem Tech Mitth 1862-63, 36

17. E. P. 222, 1863.
18. Dingl. Poly. 1864, **171**, 236, N. Repert Pharm **12**, 440; Chem. Tech. Mitth. 1863-4, 43, Pharm Centralh 1861, **3**, 500; Poly. Notizbl. 1863, **18**, 381, Wag. Jahr. 1863, **9**, 659; Poly. Centr. 1864, **30**, 410; Chem. Centr. 1864, **35**, 511; Chem. Tech. Rep. 1863, **2**, II, 51.
1. E. P. 1057, 1863; 2143, 1861
2. E. P. 3164, 1864.
3. E. P. 756, 1864.
4. Arch. Pharm (2), **117**, 274, Wicck's Gewerbeztg 1865, 14, abst. Chem Centr 1864, **35**, 992
5. Les Mondes, 1870, **22**, 648, Reb. hebdom de Chim 1872, No. 30 Amer. Chemist 1872, **3**, 195, Poly. Centr 1869, **35**, 617; Gewerbeztg. 1869, 192; Schweizer Poly. Zts 1869, 104, Am. J. Pharm 1869, **41**, 370. Chem. News, 1869, **19**, 272
6. E. P. 86602, 1869.
7. E. P. 3002, 1866
8. L. Luther, U. S. P. 71189, 1867
9. E. Wildman, U. S. P. 91393, 1869
10. H. Libbey, U. S. P. 48187, 1865
11. E. Tscheuschner, D. R. P. 14625, abst. Wag. Jahr 1861, **7**, 943.
12. J. McClelland, U. S. P. 96132, 1869, 105823, 1870, E. P. 2785, 1867.
13. J. Babcock, W. Leonard and E. Crane, U. S. P. 136953, 1873
14. R. Boettger, E. P. 3842, 1878. See also Chem. Centr. 1879, **50**, 750; Jahr. phys. Ver. Frankfurt a. M. 1877-78, 23
15. A. Starr, U. S. P. 158188, 1871
16. W. Cunliffe, E. P. 2802, 1873. A. McDougall, E. P. 8823, 1891.
17. T. Forster, E. P. 3178, 1871
18. F. Lambert, E. P. 759, 1878. L. Merriam, E. P. 3888, 1885. A. Schanschiff, E. P. 5202, 1885. A. Meygret, U. S. P. 756176, 1904.
19. C. Townsend and A. Rollason, E. P. 2972, 1871. L. Cavanaugh, E. P. 133180, 1919, abst. J. Soc. Dyers Col 1920, **36**, 26
20. O. Fillion, U. S. P. 102798, 1870
21. A. Fell, U. S. P. 170360, 1875.
22. U. S. P. 126698, 1872
23. D. R. P. 8727, 1879; abst. Poly. Notizbl 1880, **35**, 158, J. A. C. S. 1880, **2**, 103; Ber. 1880, **13**, 295.
24. U. S. P. 104241, 1870.
25. Dingl. Poly. 1871, **200**, 224, Musterztg. 1871, No. 15, and No. 41.

hoven,¹ are indicative of the trend of development from 1870 to 1880. During this period, experimenters were working indefatigably in endeavors to lessen the extreme contractility of nitrocellulose when dissolved in low boiling fluid combinations, but as yet, without a large measure of success. The "collodolith" of Schippang and Wehenkel,² appeared during this decade.

From 1881 to 1890, the accumulated knowledge and experience are reflected in the greatly diversified uses to which the collodion lacquers were applied as exemplified in the suggestions of J. Cousins,³ A. de Pont,⁴ L. Groth,⁵ H. Froedman,⁶ L. Faver,⁷ C. Schmidt,⁸ F. Schmalz,⁹ E. Potter,¹⁰ E. Dumas,¹¹ H. Abbot,¹² H. Aron,¹³ Chardon,¹⁴ S. Hahn,¹⁵ C. Laval,¹⁶ F. Moore,¹⁷ H. Schulze-Berge,¹⁸ A. Simpson,¹⁹ L. Mestaniz,²⁰ T. Reinherz,²¹ and L. Favre.²²

Meanwhile interest in the development of the pyroxylin plastics had been awakened, and the use of non-hygroscopic solvents as amyl acetate had been described, which had a natural tendency to limit the application of the more volatile collodion

Deut Indztg 1871, No. 22, Poly Centr 1871, **37**, 659, Chem Tech Mitth 1870 71, 105, 1871 2, 47 Poly Centr 1872, **38**, 827, J. C. S. 1873, **26**, 207; Wag. Jahr 1872, **18**, 816, Jahr Chem 1872, **25**, 1075. See also Bull Soc Chim 1871, **16**, 384, Jahr Chem 1871, **24**, 1111.

26 Deut Indztg 1867, 5, Wied's Gewerbeztg 1867, 96, Poly Centr 1867, **33**, 198, Chem Tech Rep 1867, **6**, 1, 95.

1. F. P. 89853, 1870.

2. D. R. P. 9890, 1879, abst Chem Ztg 1880, **4**, 141, Jahr Chem. 1880, **33**, 1310.

3. E. P. 851, 1889.

4. E. P. 383, 1887.

5. E. P. 1503, 1885.

6. E. P. 10659, 1886, abst J. S. C. I. 1887, **6**, 550.

7. U. S. P. 415100, 1887.

8. D. R. P. 34020, abst Industbl 1886, 135, Chem Ind 1886, **9**, 125, Chem Tech Rep 1886, **25**, 1, 157.

9. U. S. P. 313245, 1885.

10. E. P. 14171, 1888.

11. E. P. 12111, 1887; abst J. S. C. I. 1887, **6**, 620, 1888, **7**, 537, 540.

12. U. S. P. 310112, 1884.

13. E. P. 2043, 1882.

14. Bull Soc Franc Phot 1881, **27**, 40.

15. E. P. 33, 1883.

16. U. S. P. 242337, 1881, abst J. A. C. S. 1881, **3**, 160.

17. U. S. P. 284970, 1883.

18. U. S. P. 283424, 1883.

19. E. P. 5433, 1884.

20. E. P. 5974, 1883.

21. U. S. P. 417284, 1889. Luxemb. P. 846, 1887. E. P. 6547, 1887. Belg. P. 77309, 81115, 1888. Ital. P. 21840, 1887. Aust-Hung. P. 22419, 49212, 1887.

22. E. P. 18016, 1889.

lacquers to specific purposes where solvent hygroscopicity and extreme contractility were of minimum import. The decade therefore to 1900 was devoid of the research in this field which had characterized the previous periods. The lacquer compositions of W. Wise,¹ A. McDougall,² R. Biewend,³ E. Breuer,⁴ C. King and R. Jellicoe,⁵ T. Schlumberger,⁶ E. Bronnert and T. Schlumberger,⁷ Dubell,⁸ C. Rott,⁹ C. Henry,¹⁰ P. Leder,¹¹ and A. Wolkersdorfer¹² typify advancement and indicate the scope of application.

From 1901 to the present time, the true collodion lacquers have, in a large measure, been superseded by the celluloid and pyroxylin lacquers except for specific purposes. Among these may be recorded the activities of L. Chischin,¹³ Akt.-Ges. f. Anilin-Fabrikation,¹⁴ C. Gould,¹⁵ Pontite, Ltd., and S. de Pont,¹⁶ Wickels Metalpapierwerke,¹⁷ A. Tolmer and A. Rochereau,¹⁸ F. Matas y Rodes,¹⁹ E. Milo and E. Richardson,²⁰ C. Lubeck and M. Payet,²¹ H. Mann,²² H. Bindewald,²³ A. Chaplet,²⁴ M. Anthes and E. Lloyd,

1. E. P. 3770, 1890.
2. E. P. 8823, 1891; abst. J. S. C. I. 1891, **10**, 587; 1892, **11**, 475.
3. E. P. 14862, 1894.
4. Ber. 1891, **24**, 544.
5. E. P. 24695, 1893; abst. J. S. C. I. 1894, **13**, 89; 1895, **14**, 98, 169.
6. Belg. P. 128822, 1897.
7. U. S. P. 573132, 1896. E. P. 6858, 1896. D. R. P. 93009.
8. Neues Erfind. Erfahr. 1895, **23**, 305.
9. E. P. 9737, 1898.
10. E. P. 20092, 1899.
11. U. S. P. 636818, 1899.
12. Ber. 1894, **27**, 815.
13. E. P. 18599, 1903; abst. J. S. C. I. 1904, **23**, 713.
14. D. R. P. 161213, 1903; abst. Chem. Centr. 1905, **76**, II, 663. D. R. P. Anm. A-23064; abst. Kunst. 1913, **3**, 420. E. P. 9962, 1904; abst. J. S. C. I. 1905, **24**, 248. E. P. 17953, 1913; abst. C. A. 1915, **9**, 388; J. S. C. I. 1914, **33**, 838. F. P. 339654, 1904. F. P. 349884, 1904; abst. J. S. C. I. 1905, **34**, 855. F. P. 461034, 1913; abst. J. S. C. I. 1914, **33**, 93; C. A. 1914, **8**, 2482. Belg. P. 259073, 1913. Aust. P. 24952.
15. E. P. 24525, 1902.
16. E. P. 3826, 1904; abst. J. S. C. I. 1905, **34**, 281.
17. E. P. 13485, 1904; abst. J. Soc. Dyers Col. 1904, **20**, 191; 1905, **21**, 49, 191.
18. F. P. 329854, 1903; abst. J. S. C. I. 1903, **22**, 1044.
19. F. P. 349782, 1904; abst. J. S. C. I. 1905, **24**, 734.
20. E. P. 20874, 1900.
21. F. P. 400907, 1908.
22. U. S. P. 700793, 1902; abst. J. S. C. I. 1902, **21**, 1074.
23. F. P. 356444; abst. C. A. 1907, **1**, 511. D. R. P. 170059; abst. Wag. Jahr. 1906, **52**, II, 549. E. P. 15912, 1905.
24. Rev. gen. chim. 1908, **11**, 314; abst. C. A. 1909, **3**, 1693.

Ltd.,¹ L. Degorce,² Soc. Weiluc et Cie,³ P. Gemain,⁴ A. Payne,⁵ S. Zambuhl and H. Hall,⁶ P. Whalen and C. Whalen,⁷ F. Tiller, O. Benzinger and R. Meyer,⁸ J. Ludwig,⁹ N. Hornstein,¹⁰ K. Tanimura,¹¹ F. Rawson and Knight & Co.,¹² C. Schroeder, L. Levi and A. Lasche,¹³ Soc. Dellanoy et Bonte,¹⁴ E. Podszus,¹⁵ L. Wolf and E. Büchner,¹⁶ H. Soar,¹⁷ and the Soc. Anon. de Traitments Chimiques.¹⁸ To-day, except in relatively unimportant fields, the collodion lacquers with alcohol-ether or equivalent low boiling solvent, have been superseded by the pyroxylin lacquers or celluloid varnishes.

Celluloid Lacquers. The decreased contractility of the plastic cellulose nitrates admitted the use of low boiling solvents without the disadvantages experienced with the nitrocottons in the absence of plastifying agents. G. Pigott in 1867 lacquered wire with parkesine;¹⁹ J. Drinkwater²⁰ employed xylonite varnish as a cement; Raudnitz advocated celluloid cement in photography;²¹ H. Parkes added carbon tetrachloride along with the camphor;²² while H. Reichenbach²³ preferred fusel oil. As a class, these lacquers have greatly increased adhesiveness as compared with the collodions, and in addition--of course--are highly thermo-

1. E. P. 24214, 1907; abst. J. S. C. I. 1908, **27**, 592.
2. F. P. 377039, 1907; abst. Mon. Sci. 1909, **71**, 23.
3. E. P. 26469, 1908; abst. C. A. 1910, **4**, 1552.
4. Belg. P. 186658, 1905.
5. E. P. 28415, 1907; abst. J. S. C. I. 1909, **28**, 383.
6. E. P. 14880, 1909; abst. C. A. 1911, **5**, 2339.
7. E. P. 8022, 1909; abst. C. A. 1911, **5**, 218.
8. F. P. 381195, 1907; abst. J. S. C. I. 1908, **27**, 81. E. P. 18416, 1907.
9. F. P. 371683, 1906.
10. First addition, Oct. 10, 1910, to F. P. 429166, 1910; abst. J. S. C. I. 1911, **30**, 1208, 1310.
11. E. P. 24129, 1912.
12. E. P. 10928, 1911.
13. U. S. P. 951582, 1910; abst. C. A. 1910, **4**, 1515.
14. F. P. 430601, 1911; abst. Mon. Sci. 1913, **79**, 24.
15. E. P. 3118, 1912; abst. C. A. 1914, **8**, 2611.
16. Zts. physik. Chem. 1915, **89**, 271; abst. Chem. Zentr. 1915, **86**, I, 1292.
17. E. P. 134160, 1919.
18. F. P. 480230, 1916; abst. C. A. 1917, **11**, 1275; J. S. C. I. 1917, **36**, 132.
19. E. P. 3157, 1867.
20. F. P. 2625, 1872.
21. Phot. Corresp. 1889, 569; abst. Chem. Tech. Rep. 1889, **28**, II, 156.
22. U. S. P. 265337, 1882. F. P. 132495, 1879. Belg. P. 56230, 1884.
23. E. P. 1866, 1879. D. R. P. 10210; abst. Dingl. Poly. 1880, **238**, 262; Chem. Ztg. 1880, **4**, 584; Jahr. Chem. 1880, **33**, 1369.

plastic. The Mercurine Manufacturing Co. patented¹ a combination of graphite, celluloid and mercury (?) as a lubricant; W. Carpenter described² a celluloid waterproof material for paper impregnation; J. Mayer added³ essential oils as lavender; C. Claus⁴ decreased the inflammability of the zylodine (eburnam) by the addition of basic magnesium salts. Venice turpentine,⁵ pigments and dyestuffs,⁶ acetic acid,⁷ acetone,⁸ magnesium chloride,⁹ shellac,¹⁰ calcium chloride,¹¹ gelatin,¹² methylated spirit,¹³ copal,¹⁴ amyl acetate,¹⁵ ethyl acetate,¹⁶ acetone and wax,¹⁷ linseed oil,¹⁸ oil of cedar,¹⁹ *p*-nitrotoluene,²⁰ vinyl esters (acetate or chloracetate),²¹ amyl formate, ethyl butyrate,²² methylethyl ketone,²³ castor oil,²⁴ Canada balsam,²⁵ oil of juniper,²⁶ benzoin,²⁷ and alumi-

- 1 D. R. P. 7859; abst. Wag. Jahr. 1880, **26**, 824.
- 2 U. S. P. 253840, 1882.
- 3 D. R. P. 12778; abst. Wag. Jahr. 1881, **27**, 943.
- 4 E. P. 3072, 1881; abst. J. S. C. I. 1882, **1**, 201.
- 5 Cie. gen. de Chromolithie, E. P. 166, 1883. D. R. P. 27031, 1883.
- 6 E. Andres, Proc. Amer. Pharm. Assoc. 1892, **40**, 541; Zts. Oest. Apoth. Ver. 1892, 314; Uhland's W. T. **6**, 447, Met. Arb. **18**, 403, Chem. Tech. Rep. 1892, **31**, I, 130.
- 7 J. Bourmumeau, E. P. 24901, 1893.
- 8 Buchheister, Pharm. Centralh. 1899, **41**, 620, Amer. Pharm. Assoc. 1900, **48**, 542.
- 9 L. Bussy, H. Philippe and P. Bussy, E. P. 27534, 1897.
- 10 A. Furse, E. P. 25675, 1896, abst. J. S. C. I. 1897, **16**, 924.
- 11 H. Beau, F. P. 322457, 1902.
- 12 F. Alary-Ruelle and A. Choisy, F. P. 328357, 1903.
- 13 J. Bonnaud, E. P. 8063, 1901, abst. J. S. C. I. 1902, **21**, 487.
- 14 J. Bonnaud U. S. P. 697790, 1902, abst. J. S. C. I. 1902, **21**, 625.
- 15 D. R. P. 180489; abst. Wag. Jahr. 1907, **53**, II, 465, Chem. Ztg. Rep. 1907, **31**, 92; Chem. Ind. 1907, **30**, 87. Can. P. 78060. Aust. P. 27202, 1906.
- 16 Belg. P. 159200, 1901. Norw. P. 10823, 1901.
- 17 S. Hobday, E. P. 10110, 1904. See also Kunst. 1919, **9**, 209.
- 18 Akt. Ges. f. Anilin-Fabrikation, Aust. P. 24952, 1906; D. R. P. 161213.
- 19 M. Friedlander and P. Tuebben, E. P. 23547, 1909.
- 20 J. Mendess, E. P. 12128, 1912. F. P. 459048, 1913, abst. C. A. 1915, **9**, 156.
- 21 C. Lounds, U. S. P. 1146336, 1915; abst. C. A. 1915, **9**, 2432.
- 22 Dusseldorfer Celluloid-Fabrik Ges., E. P. 15945, 1911.
- 23 Chem. Fabr. Griesheim-Elektron, E. P. 15271, 1914.
- 24 Triplex Safety Glass Co., E. P. 15386, 1913. New Zeal. P. 34746, 1914. Can. P. 169308, 169470. The "non-scatterable" glass of L. Mascart (U. S. P. 1342267, 1342268, C. A. 1920, **14**, 2247) is similar.
- 25 P. Pommier, F. P. 435417, 1910.
- 26 H. Dittmar, E. P. 2064, 1911. D. R. P. 266384; abst. C. A. 1914, **8**, 2041.
- 27 L. Woolldridge and A. Fox, E. P. 105137, 1916, abst. C. A. 1917, **11**, 2267; J. S. C. I. 1917, **36**, 544.
- 28 A. Christiansen, E. P. 29026, 1913.
- 29 O. Egner, U. S. P. 1202495, 1916; abst. C. A. 1917, **11**, 216.

num¹ and ferric oxide² comprize the essence of subsequent inventions for the production of celluloid lacquers intended for specific purposes.

H. Lüttke³ substitutes nitroglycerol for camphor in lacquer formation, but probably this idea never passed beyond the patent issuance stage. The celluloid lacquers more recently have been advocated for the coating of fabrics⁴ and balloon envelopes,⁵ weatherproofing of tiles,⁶ waterproofing of cartridge cases,⁷ cements for leather⁸ and ebonite,⁹ applying designs to windows¹⁰ and other smooth surfaces,¹¹ the frosting or graining of a base surface,¹² and for the glazing of tiles,¹³ painting books,¹⁴ preservation of eggs,¹⁵ match heads,¹⁶ perfumed blocks¹⁷ and the coating of metals.¹⁸

In furniture¹⁹ and other polishes,²⁰ enamels,²¹ and the protection of mirrored surfaces,²² celluloid lacquers have been extensively employed. P. Majorana,²³ C. Tissier and P. Magnier,²⁴ J. Bell and H. Vollin,²⁵ C. Dreyfus,²⁶ and A. Hueck and L. Fischer²⁷ have

- 1 J. Bell and H. Vollin, F. P. 470092, 1913, and addition 19520 thereto
- 2 J. Adler, U. S. P. 1147066, 1915, abst. C. A. 1915, **9**, 2460
- 3 E. P. 24955, 1902, abst. J. S. C. I. 1903, **22**, 318.
- 4 N. Tornau, E. P. 16795, 1899
- 5 H. Hoernes, Gummi-Ztg. 1911, **25**, 1281, abst. J. S. C. I. 1911, **30**, 797, C. A. 1912, **6**, 1230. S. Groves and T. Ward, E. P. 131093, 1918, abst. C. A. 1920, **14**, 227. See E. P. 128659, abst. C. A. 1919, **13**, 3028.
- 6 M. Storp, E. P. 7561, 1901
- 7 F. Oliver, E. P. 11666, 1894, 17747, 1894
- 8 P. Couille, F. P. 458038, 1912, abst. C. A. 1914, **8**, 2277, Kunst 1914, **4**, 14
- 9 E. P. 12075, 1915, abst. C. A. 1917, **11**, 281
- 10 E. Mitchell, E. P. 9242, 1905
- 11 R. Fournier, E. P. 23600, 1911
- 12 R. McQuitty, E. P. 11614, 1914
- 13 P. Thomsen and W. van Dam, E. P. 8880, 1913
- 14 H. Warne and C. Godfrey, E. P. 6303, 1913
- 15 H. Jerne, E. P. 2145, 1911
- 16 L. Carre, E. P. 117, 1908. F. Humerlein (U. S. P. 805466, 1905) finishes wooden articles with a mixture of copal, gum-para, and celluloid
- 17 L. Edlertsen, E. P. 13993, 1904, U. S. P. 825268, 1906, 975405, 1910.
- 18 G. Klose, U. S. P. 858660, 1907. H. Babis, U. S. P. 1330421, 1919.
- 19 S. Strauss, D. R. P. 279127, 1913, abst. C. A. 1915, **9**, 1127.
- 20 R. Besel, F. P. 459187, 1913. S. Zambuhl, E. P. 14880, 1909.
- 21 B. Vient, U. S. P. 1251710, 1918, abst. C. A. 1918, **12**, 764.
- 22 H. Miller, U. S. P. 621360, 1899
- 23 U. S. P. 1275063, 1918; abst. C. A. 1918, **12**, 2053.
- 24 F. P. 320931, 1902, abst. Mon. Sci. 1903, **59**, 124.
- 25 F. P. 468376, 1913.
- 26 E. P. 17635, 1891; abst. J. S. C. I. 1891, **10**, 873, 1046, 1892, **11**, 29, 46
- 27 E. P. 17311, 1902. See "Ago" Lederkitt Indust.-Ges. m. b. H. Aust. P. Ann. 1447, 1912; abst. Chem. Ztg. 1913, **37**, 799.

described special methods of celluloid lacquer usefulness. F. Koetsch¹ has described the dangers of intoxication through the use of these lacquers, and M. Schall² has detailed a comprehensive review of the art as a whole.³

Amyl Acetate Pyroxylin Lacquers. In 1882 J. Stevens⁴ patented the use of amyl acetate in conjunction with pyroxylin, and the next month appeared a nitropaper varnish with amyl acetate as an ingredient.⁵ In 1884⁶ and the succeeding year,⁷ W. Wilson and J. Storey gave a clear description of the principles underlying the solution of the cellulose nitrates in amyl acetate menstrua, and thereby contributed signally to the subsequent development of this important industry. F. Crane in a series of patents,⁸ together with his father-in-law, R. Hale,⁹ laid down by patent description the principles of present day pyroxylin lacquer combinations. Their chemist, W. Field, patented propyl and butyl acetates for this same purpose,¹⁰ and much litigation resulted. H. Trimble,¹¹ E. Todd,¹² G. Buchner,¹³ A. Finger and W. Menzel,¹⁴ and the Celluloid Co.¹⁵ followed with manufacturing

- ¹ Munch. med. Wochschr. 1915, **62**, 1567, abst. C. A. 1916, **10**, 1103.
- ² Kunst. 1911, **1**, 202, 361, 391, 411; 1916, **6**, 141, 157; abst. C. A. 1916, **10**, 1330; 1917, **11**, 1316.
- ³ J. Helen, Belg. P. 263428, 1913 H. Marquardt, D. R. P. 12769, 1880.
- ⁴ U. S. P. 269340, 1882.
- ⁵ Cie. Generale de Chromolithie, D. R. P. 27031, 1883; abst. Ber. 1884, **17**, 246; Wag. Jahr. 1884, **30**, 1201. E. P. 466, 1883.
- ⁶ E. P. 6051, 1884, abst. J. S. C. I. 1885, **4**, 289; Bull. Soc. Chim. 1885, **44**, 342; Wag. Jahr. 1885, **31**, 1140 U. S. P. 294557, 1884.
- ⁷ E. P. 491, 4668, 1885. U. S. P. 340026, 1886; abst. Chem. Ind. 1886, **9**, 126.
- ⁸ E. P. 4954, 1887; 12684, 1890, 3345, 1891 U. S. P. Appl. Ser. No. 246852, 1887. See also Phot. Corresp. 1889, **26**, 295, 313; 1892, **29**, 407; Eder's Jahr. Phot. 1890, 184. Chem.-Tech. Rep. 1893, **32**, II, 171.
- ⁹ E. P. 5586, 5791, 7376, 7377, 11281, 1887, abst. J. S. C. I. 1888, **7**, 330, 392; Chem. Tech. Rep. 1888, **27**, II, 129; Chem. Ztg. 1888, **12**, 1145. U. S. P. Appl. Ser. No. 246852, 1887. U. S. P. 471422; abst. J. A. C. S. 1892, **14**, 77. Aust. P. 17684. Belg. P. 78913, 1887. F. P. 184548, 1887.
- ¹⁰ E. P. 15771, 1887; 15772, 1887; 8253, 1887. U. S. P. 381354, 1888; abst. J. A. C. S. 1888, **10**, 118. See also J. A. C. S. 1893, **15**, 140; 1894, **16**, 487; abst. Wag. Jahr. 1894, **40**, 1134. See Air Board Specification D. 8, December 1917.
- ¹¹ Am. J. Pharm. 1898, **70**, 54. Jahr. Chem. 1886, **39**, 1297.
- ¹² U. S. P. 384005, 1888; 428654, 1890; 450264 1891; 4873701, 1892; abst. J. A. C. S. 1890, **12**, 236. E. P. 6870, 1887.
- ¹³ Bayer. Gewerbebl. 1888, 679; abst. Chem. Centr. 1889, **60**, I, 685; Jahr. Chem. 1889, **42**, 2835; Wag. Jahr. 1888, **34**, 1161.
- ¹⁴ U. S. P. 363131, 1887.
- ¹⁵ E. P. 682, 1890 abst. J. S. C. I. 1890, **9**, 231, 350.

details. The claims of J. Eder¹ for priority in this field for Waterhouse² appear not to be well grounded.

The advantages of amyl acetate over all other simple solvents heretofore proposed are the high boiling point, low vapor tension, diminished solubility in water, absence of hygroscopicity (film blushing) and the ability to produce acceptable lacquers containing a large proportion of non-solvent, especially benzene. Amyl acetate also imparts to nitrocellulose films in a high degree, the desirable properties of smoothness, great luster and high tensile strength. Immediately investigators turned their attention to the commercial exploitation in all the available avenues, of amyl acetate lacquers, the period 1890-1900 bringing forth the processes of W. Kester,³ A. Seher,⁴ W. Cutler,⁵ L. Paget,⁶ S. Bennett,⁷ J. Stevens,⁸ Pouteaux,⁹ F. and G. Jones,¹⁰ A. Latham and J. Nourbourn,¹¹ L. Bethisy and Soc. M. Rose et Cie.¹² and H. Bentley.¹³

The next decade saw further substantial advances, in quality, diversity and ramifications, in the methods and refinements published by J. Daly,¹⁴ Y. Schwarz,¹⁵ Transparent Cellulose Products Co.,¹⁶ W. Bruckner,¹⁷ F. Bernhardt,¹⁸ M. Bottler,¹⁹ E. Clossmann,²⁰ B. Buchstab,²¹ G. Dosselman,²² G. Kraemer and Kraemer

1. Dingl. Poly 1889, **274**, 34. See Eder's Ausführliches der Photographie.
2. Jahr. Chem 1889, **42**, 2877.
3. U. S. P. 445528, 1891.
4. U. S. P. 470451; abst. J. A. C. S. 1892, **14**, 73.
5. E. P. 7688, 1892; abst. J. S. C. I. 1892, **11**, 479, 728, 829.
6. E. P. 22137, 1893. U. S. P. 507749, 1893.
7. E. P. 12693, 1896. U. S. P. 578714, 1897.
8. U. S. P. 559824, 1896; 595355, 1897; 615319, 1898; 622727, 1899.
9. Chemist and Druggist, 1896, 372; abst. J. S. C. I. 1896, **15**, 228.
10. E. P. 17717, 1896. U. S. P. 587211, 1897.
11. E. P. 15249, 1895.
12. E. P. 347303, 1904; abst. J. S. C. I. 1905, **24**, 344.
13. U. S. P. 690915, 1902; abst. J. S. C. I. 1902, **21**, 488.
14. U. S. P. 694946, 1902; abst. J. S. C. I. 1902, **21**, 474. E. P. 5348, 1902; abst. J. S. C. I. 1902, **21**, 912. U. S. P. 707306, 1902.
15. F. P. 320452, 1902.
16. E. P. 11505, 1902.
17. D. R. P. 241820; abst. Wag. Jahr. 1912, **58**, II, 509; J. S. C. I. 1912, **31**, 227. D. R. P. Anm. B-52888, 1909; E. P. 1799, 1910.
18. E. P. 20728, 1909; abst. J. S. C. I. 1909, **28**, 1246.
19. Die Lack und Firnisfabrikation, 1908, 130. Kunst. 1912, **2**, 9; 1913, **3**, 461; abst. C. A. 1912, **6**, 2544; 1914, **8**, 828.
20. U. S. P. 861435, 1907. E. P. 8618, 1907.
21. F. P. 407862, 1909; D. R. P. 216307, 1909; abst. J. S. C. I. 1909, **28**, 1320; Wag. Jahr. 1910, **56**, II, 585; C. A. 1910, **4**, 836.
22. U. S. P. 893987, 1908.

& van Elsberg Ges.,¹ A. Patat et Cie.,² H. Pearson,³ E. Ohr and O. Schlegel,⁴ F. Rampichini,⁵ W. Vincent,⁶ A. Lukacs,⁷ K. Wagishauser,⁸ Genthiner Cartonpapierfabrik, G. m. b. H.,⁹ H. Peters,¹⁰ P. Girard,¹¹ F. Royle,¹² F. Hoppe,¹³ and C. Massmann.¹⁴

Of the more recent refinements from 1911 to the present (1920) time, may be mentioned the substitution of amyl acetate, either wholly or in part, by aldol as acetaldol,¹⁵ cyclopentanone, cyclohexanone,¹⁶ lactic esters (ethyl lactate) with xylene,¹⁷ acetins, butyrins, benzoic acid, glycerol and glycol esters,¹⁸ ethyl acetate,¹⁹ neutral alkyl carbonates,²⁰ aliphatic ethylidene esters (ethylidene acetate, and diacetate),²¹ polymerized vinyl esters,²² acetophenone, nitromethane, benzaldehyde, salicylaldehyde,²³ metal resinolates,²⁴

1. U. S. P. 942395, 1909. E. P. 11928, 1907; abst. J. S. C. I. 1907, **26**, 1046. E. P. 26201, 1905; abst. J. S. C. I. 1906, **25**, 864. F. P. 379589, 1907; abst. C. A. 1909, **3**, 1092. Aust. P. 25570, 1906.
2. F. P. 361954, 1905; abst. J. S. C. I. 1907, **26**, 212.
3. E. P. 5072, 1906, 17243, 1908. U. S. P. 927674, 1909; abst. J. S. C. I. 1909, **28**, 905.
4. F. P. 363592, 1906; abst. J. S. C. I. 1906, **25**, 897.
5. E. P. 14586, 1910; 4253, 1911, 7086, 1913. F. P. 415945, 1910.
6. D. R. P. Anm. R-32601, 1911.
7. E. P. 21593, 1908; abst. J. S. C. I. 1909, **28**, 1268. F. P. 398263, 1909.
8. E. P. 24587, 1906.
9. E. P. 10222, 1912; abst. J. S. C. I. 1913, **32**, 34; Kunst. 1914, **4**, 37. Aust. P. Anm. A 7597, 1909; abst. Kunst. 1912, **2**, 340.
10. D. R. P. 237772, 1909; abst. C. A. 1912, **6**, 2008. Aust. P. 72643, 1916; abst. C. A. 1917, **11**, 1023.
11. E. P. 14293, 1910; abst. J. S. C. I. 1911, **30**, 1171.
12. F. P. 430939, 1910.
13. E. P. 22311, 1910.
14. D. R. P. 236613, 1910; abst. C. A. 1912, **6**, 2012.
15. D. R. P. Anm. M-40964.
16. Du Pont de Nemours Powder Co., U. S. P. 1234921, 1917; abst. J. S. C. I. 1919, **38**, 319-A; C. A. 1917, **11**, 2604. E. P. 22622, 1912. U. S. P. 1135026, 1915; E. P. 24033, 1914; abst. J. S. C. I. 1915, **34**, 606, 956.
17. Badische Anilin u. Sodafabrik, E. P. 21368 and 23554, 1912; U. S. P. 1166790, 1916; abst. J. S. C. I. 1913, **32**, 1021; 1916, **35**, 263.
18. R. Gruter, U. S. P. 1195673, 1916; abst. C. A. 1916, **10**, 2646; J. S. C. I. 1916, **35**, 1026. F. P. 464617, 1913; abst. J. S. C. I. 1914, **33**, 557.
19. W. Plinatus, E. P. 16940, 1913; abst. C. A. 1915, **9**, 2589; J. S. C. I. 1915, **34**, 793.
20. S. Nitta, Jap. P. 32242, 1918; abst. C. A. 1918, **12**, 2259.
21. Chem. Fabrik. Buckau, Abteilung Dubois & Kaufmann, D. R. P. 280376, 1913; abst. C. A. 1915, **9**, 1399; Kunst. 1914, **4**, 392; J. S. C. I. 1915, **34**, 500, Chem. Zentr. 1914, **85**, II, 1371.
22. Chem. Fabrik. Griesheim-Elektron, D. R. P. 281373, 1912; abst. C. A. 1915, **9**, 1850.
23. Chem. Fabrik. Griesheim-Elektron, F. P. 474086, 1914; abst. J. S. C. I. 1915, **34**, 724.
24. Chem. Fabrik. Griesheim-Elektron, D. R. P. 291299, 1915; abst.

Para gum¹ mastic,² castor oil,³ ethyl acetate and benzene,⁴ alcohol,⁵ and acetanilid.⁶ However, it is safe to say, that up to the present time there has been no substitute for amyl acetate in pyroxylin lacquers found that has been entirely satisfactory.

The pyroxylin lacquers with amyl acetate as a base, have recently been advocated or employed for printer's blankets,⁷ production of artificial corks,⁸ waterproofing linen,⁹ hats,¹⁰ concrete,¹¹ plaster casts,¹² and the formation of matches.¹³ For some of these applications, combination with nitrated resins¹⁴ or nitrated castor oil¹⁵ have been proposed. For painting¹⁶ and lettering¹⁷ on glass, processes have been described.

The above indications for pyroxylin lacquer application have been extended by L. Lilienfeld,¹⁸ M. Ratignier and Soc. H. Per-vilhac & Cie.,¹⁹ Zapon-Lack-Ges.,²⁰ A. Lehmer,²¹ A. Cohn,²² O.

J. S. C. I. 1916, **35**, 698; addition to D. R. P. 290544. See also D. R. P. 281877, abst. Kunst. 1915, **5**, 36.

21. J. Clarac, F. P. 439648, abst. Kunst. 1912, **2**, 316.
1. J. Rovira and H. Ahrle, U. S. P. 1153574, 1915, abst. C. A. 1915, **9**, 3119.
2. O. Pickering, U. S. P. 1196144, 1916, abst. C. A. 1916, **10**, 2646.
3. S. Graves, U. S. P. 1124012, 1915.
4. F. Kniffen (E. du Pont de Nemours Powder Co.), U. S. P. 1135026, 1915, abst. J. S. C. I. 1915, **34**, 606, C. A. 1915, **9**, 1517.
5. C. Arnold (E. du Pont de Nemours Powder Co.), U. S. P. 1195131, 1916. Can. P. 179699, 1917; abst. C. A. 1918, **12**, 764.
6. A. St. Armand, E. P. 106375, 1916, abst. J. S. C. I. 1917, **36**, 736.
7. F. Ellis, U. S. P. 1231141, 1917; abst. J. S. C. I. 1917, **36**, 924.
8. I. Pink, D. R. P. 240563, addition to D. R. P. 227918, E. P. 2455, 1911, abst. J. S. C. I. 1911, **30**, 1376, 1912, **31**, 67, Kunst. 1911, **1**, 240. W. Jack, E. P. 718, 1879. Suberit-Fabrik, D. R. P. 248602, 1911, abst. C. A. 1912, **6**, 3516.
9. A. Zimmer, E. P. 24006, 1909, 6519, 1910, abst. J. S. C. I. 1911, **30**, 206. D. R. P. Anm. Z-7052. D. R. P. 242786, 1910, abst. Zts. ang. Chem. 1912, **25**, 512. See Wickels Metall-papier-werke, E. P. 13485, 1904.
10. Pearson's Patents, Ltd., E. P. 5323, 1912.
11. W. Bladen, U. S. P. 1021569, 1912.
12. F. Rathgen, Ber. 13te Hauptversammlung des deutsch. Gipsvereins, 1911, 50, abst. J. S. C. I. 1911, **30**, 622.
13. W. Mills and W. Morgan, E. P. 18028, 1915, abst. J. S. C. I. 1917, **36**, 164; C. A. 1917, **11**, 1904.
14. E. Taylor, U. S. P. 1025217, 1912.
15. J. Tronel, D. R. P. 273498, 1912, abst. J. S. C. I. 1914, **33**, 700.
16. J. Kalhous, Swiss P. 72863, 1916; abst. C. A. 1916, **10**, 2805.
17. I. Nemoto, Jap. P. 31446, 1917; abst. C. A. 1918, **12**, 86.
18. E. P. 14483, 1903; abst. J. S. C. I. 1903, **22**, 1345. E. P. 592, 1907; abst. Chem. Ztg. Rep. 1908, **32**, 73. E. P. 2998, 1907, abst. J. S. C. I. 1908, **27**, 279. Belg. P. 255276, 1913.
19. F. P. 431090, 1910.
20. D. R. P. 281265; abst. C. A. 1915, **9**, 1850; Kunst. 1913, **3**, 396.
21. D. R. P. 308615, 1917; abst. Chem. Zentr. 1919, **90**, II, 119; J. S.

Wawrzyniak,¹ E. Koontz,² E. Roggenkämper,³ H. Clarke,⁴ du Pont de Nemours and Co.,⁵ A. St. Armande,⁶ F. Hesse,⁷ H. Bindewald,⁸ Badische Anilin u. Soda Fabrik,⁹ Act. Ges. für Anilin Fabrikation,¹⁰ P. Reidel,¹¹ J. and B. Galay,¹² A. Forster,¹³ H. Helbing and G. Pertsch,¹⁴ J. de Froment,¹⁵ A. Camnitzer,¹⁶ H. Wolf,¹⁷ C. Massman,¹⁸ J. Delpech,¹⁹ and F. Lehmann and J. Stocker.²⁰

The details of cellulose nitrate lacquer formation and application have been recorded by E. Later,²¹ L. Clement and Riviere,²² C. Hebing²³ and F. Zimmer²⁴ and M. Schall.²⁵ For the mechanics of lacquering, reference is made to the process of L. Chauviere.²⁶

C. I. 1919, **38**, 283-A.

22. E. P. 16429, 1901, abst. J. Soc. Dyers Col. 1902, **18**, 260. E. P. 8194, 1912, abst. J. S. C. I. 1913, **32**, 541. F. P. 441703, abst. J. S. C. I. 1912, **31**, 886.

1. U. S. P. 1141224, 1915.
2. U. S. P. 1148908, 1915; abst. C. A. 1915, **9**, 2601.
3. D. R. P. Anm. R-31297.
4. U. S. P. 1309981, 1919, abst. C. A. 1919, **13**, 2443.
5. E. P. Appl. 25494, 1919; abst. J. S. C. I. 1919, **38**, 848-A.
6. E. P. 106375, 1916; abst. C. A. 1917, **11**, 2665.
7. D. R. P. 250029; abst. Wag. Jahr. 1912, **58**, II, 508. E. P. 10708, 1911.
8. E. P. 15912, 1905.
9. D. R. P. Anm. B. 68700, 1912, abst. Chem. Ztg. 1913, **37**, 1571.
10. D. R. P. Anm. A. 23064, 1912, abst. Chem. Ztg. 1913, **37**, 1304.
11. E. P. 21409, 1893.
12. E. P. 1715, 1909, abst. J. S. C. I. 1909, **28**, 1163.
13. E. P. 24289, 1903, abst. J. S. C. I. 1904, **23**, 184; J. S. Dyers Col. 1904, **20**, 73. D. R. P. 150825, abst. Wag. Jahr. 1904, **50**, II, 418.
14. U. S. P. 628463, 1899. E. P. 25779, 1896.
15. U. S. P. 643491, 1900.
16. U. S. P. 627296, 1899.
17. Farben Ztg. 1920, **25**, 668, abst. C. A. 1920, **14**, 2092.
18. D. R. P. 250421, 1910; abst. Chem. Ztg. 1912, **36**, 948.
19. F. P. 441555, 1912; abst. Chem. Ztg. 1912, **36**, 857.
20. U. S. P. 1185514, 1916; F. P. 471104, 1914; abst. J. S. C. I. 1915, **34**, 187; 1916, **35**, 747.
21. Foundry, 1917, **45**, 103, abst. C. A. 1917, **11**, 1312. Francke, Zts. Blechind. 1888, **17**, 841. R. Gilmour and W. Dunville & Co., E. P. 132996; abst. C. A. 1920, **14**, 358. See English Air Board Specification D. 102, June 1918. D. 23, July 1918.
22. Rev. chim. ind. 1913, **24**, 5; abst. C. A. 1913, **7**, 1621.
23. "Vergoldung und Bronsierung, 176."
24. Kunst. 1912, **2**, 6, 16; abst. C. A. 1912, **6**, 2544; 1913, **7**, 905. Kunst. 1913, **3**, 323; abst. C. A. 1914, **8**, 582. Farber Ztg. 1918, **23**, 331; abst. C. A. 1919, **13**, 2130.
25. Kunst. 1911, **1**, 201, 361. See also Kunst. 1912, **2**, 45, 71, 93; abst. C. A. 1912, **6**, 1372.
26. Soc. Anon. L'Helice Integrale, Anciens Etablissements L. Chau-

In the processes for the preparation of pyroxylin dip lacquers, the methods of R. Bradford and G. Rawlins,¹ J. Perl² and with P. Herrmann,³ may be cited, while for the formation of brush lacquers, the inventions of P. Leder,⁴ W. Love,⁵ M. Krämer,⁶ R. Lokesch,⁷ E. Bush,⁸ Kraemer & van Elsberg,⁹ are indicative. The mechanical points are covered in the descriptions of E. Rosenberg,¹⁰ T. Davidson¹¹ and Reliance Drying Room Co.¹²

Bronzing Liquids. In the application of powdered aluminum, copper and bronze and gold powders to metallic and other surfaces for protection and to enhance their beauty and utility, pyroxylin solutions of low viscosity—the so-called bronzing liquids and Chinese and Japanese paints—have been and are widely used. While H. Bessemer in 1844¹³ described the use of finely divided metals as protecting media in oily menstrua, probably H. Hoffman¹⁴ was the first to describe the combination of bronze powder with collodion for gilding purposes. The ideas of J. Eustace,¹⁵ J. Duffee,¹⁶ A. Towne,¹⁷ and R. Peterson and E.

viere, E. P. 118610, 1918; abst. C. A. 1919, **13**, 195. DeVilbiss Mfg. Co., D. R. P. Anm. V-10393, 1911. J. Perl, F. P. 233727, 1893; abst. Chem. Rev. 1896 (42), 127. T. Taliaferro, U. S. P. 1318187, 1919; abst. J. S. C. I. 1919, **30**, 916-A.

1. E. P. 24132, 1896. For the E. Keller process, see D. R. P. 220322, 246505; abst. Zts. ang. Chem. 1910, **23**, 864; 1912, **25**, 1351; Chem. Centr. 1910, **31**, I, 1309.

2. E. P. 3557, 22455, 1893. D. R. P. 69356, 84150; abst. Wag. Jahr. 1893, **39**, 1098; 1895, **41**, 1021.

3. E. P. 15327, 1894. The F. Bradley process for the coating of articles with bronze powder, is described in U. S. P. 995998, 995999, 1034761, 1088874, abst. J. S. C. I. 1912, **31**, 802; 1914, **33**, 408; C. A. 1911, **5**, 2743. U. S. P. 1077239; abst. C. A. 1914, **8**, 264. D. R. P. 256651, 1911; abst. C. A. 1913, **7**, 1998.

4. U. S. P. 974285, 1910; abst. J. S. C. I. 1910, **29**, 1371.

5. E. P. 21535, 1904. For manufacture of bronze powder, consult Bronzefarbenwerke A. G., F. P. 289827, 1899, abst. J. S. C. I. 1903, **22**, 150.

6. E. P. 25362, 1902.

7. E. P. 20037, 1898; abst. J. S. C. I. 1898, **17**, 975; 1899, **18**, 96.

8. E. P. 9624, 1895; abst. J. S. C. I. 1895, **14**, 534, 622.

9. F. P. 379589; abst. Mon. Sci. 1908, **69**, 167.

10. E. P. 12070, 1913; abst. C. A. 1914, **8**, 3635.

11. E. P. 16554, 1913; abst. J. S. C. I. 1914, **33**, 355.

12. E. P. 100869, 1916; abst. J. S. C. I. 1916, **35**, 933.

13. E. P. 10011, 1844; 13819, 1851.

14. U. S. P. 18338, 1857.

15. E. P. 1442, 1865.

16. U. S. P. 102198, Re. 3962, 1870.

17. U. S. P. 132993, 1872; 149004, 1874.

Frost,¹ did not include the nitrocellulose lacquer combinations.

C. Rotter in 1873² combined mica, silver, aurosit and collo-dion; the bronze paints of S. Pichler,³ E. and W. Leuscher,⁴ A. and W. Gill,⁵ and E. and M. Williams and C. May⁶ being analogous.

Advances in method of preparation and application of these bronzing liquids are detailed in the publications of R. Smith,⁷ A. Cutler,⁸ L. Kurz,⁹ H. Gall,¹⁰ J. and B. Galay,¹¹ E. Palk, H. Basset and W. Nash,¹² G. Reuhl,¹³ H. Heil and E. van den Kerckhoff,¹⁴ F. Tiller, O. Benzinger and R. Meyer,¹⁵ C. Ludewig,¹⁶ V. Seitz,¹⁷ J. Ellis,¹⁸ E. Golby and H. Ahrlé,¹⁹ J. Pighills,²⁰ A. Bonger,²¹ and M. Fehrerger.²² These liquids may be either applied by hand by brushing, or more economically by a compressed air spray. For mechanical details of the latter, the descriptions of O. Wold,²³ A. Ford,²⁴ Leipziger Tangier Manier, A. Grube,²⁵ J. Gaudit,²⁶ P. Gorlich²⁷ and B. Hall²⁸ should be consulted.²⁹

Imitation Gold Leaf. Instead of mixing aluminium and

- 1 U. S. P. 209625, 1878
- 2 U. S. P. 139333, 1873
- 3 E. P. 9261, 1891, abst. J. S. C. I. 1895, **14**, 195
- 4 E. P. 18681, 1902, abst. J. S. C. I. 1903, **22**, 211
- 5 E. P. 22610, 1891, abst. J. S. C. I. 1892, **11**, 88, 1017
- 6 E. P. 4169, 1892, abst. J. S. C. I. 1892, **11**, 292, 1893, **12**, 198, 363
- 7 E. P. 7442, 1907
- 8 E. P. 13221, 1908. See also C. Paiseau-Feil, D. R. P. 222248
- 9 F. P. 398028, 1908, abst. C. A. 1910, **4**, 1864
- 10 F. P. 398084, 1908, abst. J. S. C. I. 1909, **28**, 805
- 11 U. S. P. 1011181, 1911. E. P. 1715, 19772, 1909; abst. J. S. C. I. 1910, **29**, 483
- 12 E. P. 24627, 1908, abst. J. S. C. I. 1909, **28**, 1319
- 13 D. R. P. 176121, abst. Wag. Jahr. 1906, **52**, II, 512
- 14 D. R. P. 217852, 1908, abst. C. A. 1912, **6**, 1813, J. S. C. I. 1910, **29**, 439, Zts. ang. Chem. 1910, **23**, 525; Chem. Zentr. 1910, **81**, I, 705, Chem. Tech. Rep. 1910, **34**, 114, Chem. Ind. 1910, **33**, 86, Wag. Jahr. 1910, **56**, II, 570
- 15 F. P. 381195, 1907.
- 16 F. P. 351274, 1905, abst. J. S. C. I. 1905, **24**, 842
- 17 Aust. Ann. A. 6754, 1911, abst. Kunst. 1912, **2**, 320.
- 18 E. P. 4699, 1911
- 19 E. P. 17427, 1910.
- 20 E. P. 106286, 1917
- 21 U. S. P. 1220947, 1917, abst. C. A. 1917, **11**, 1735.
- 22 U. S. P. 1157768, 1915, abst. C. A. 1915, **9**, 3369
- 23 U. S. P. 1017358, 1912.
- 24 U. S. P. 1008129, 1911
- 25 D. R. P. 267328, 1912, abst. C. A. 1914, **8**, 1362
- 26 Rev. gen. mat. col. **16**, 61, abst. C. A. 1912, **6**, 2321
- 27 D. R. P. 247816, 1911, abst. C. A. 1912, **6**, 2856.
- 28 U. S. P. 1261122, 1918.
- 29 R. Kayser, Bayer. Ind. u. Gewerbe. 1889, 92; Industriell. 1889,

bronze powders with nitrocotton solutions and applying mechanically or by hand, the metallic leaf may be first formed and applied in the dry manner, being especially advantageous in such uses as the lettering of books, and the other uses to which gold leaf is ordinarily applied. This is comparatively a new art which has rapidly grown to large proportions, the earlier methods of F. Volkman,¹ F. Albrecht,² J. and W. Tennant,³ L. Bracher, W. Collyer and J. Cassels,⁴ M. Hinzelmann,⁵ F. Simeons and J. Mainzer,⁶ and H. Fooks,⁷ being more in the nature of the bronzing liquids just described.

In 1893, however, H. Ernst⁸ described a process for obtaining gold leaf, to be employed for the same purpose as metal gold leaf, and which is performed by pouring a mixture of 70% 75% collo-dion (12% solution) and oil color (20% 30%) on a polished surface, and moistening the very thin leaves when perfectly dry. This undoubtedly is the priority patent in this field.

The present general composite method is to float or flow the bronzing liquid with the powdered metal uniformly incorporated therein, over water by means of a traveling hopper moving on a track. The solvent disseminates in the water and the film is passed over driers and cut into squares. This general method is embraced in the patented processes of H. Gregory,⁹ Diamond Decorative Leaf Co.,¹⁰ J. Potter,¹¹ H. Johnson,¹² L. Kurz,¹³ N. Gentzel,¹⁴ K. Olson,¹⁵ W. Ker,¹⁶ J. Fichtmueller,¹⁷ and Societe

163, abst Chem Tech Rep 1889, **28**, I, 109. O. Prager, Seifensztg 1919, 769, 794, 825, 851. abst. Chem Zentr. 1920, **91**, II, 645.

1. E. P. 23, 1869.

2. E. P. 8890, 1897. In this connection see E. P. 13838, 1893, 21283, 1895.

3. E. P. 8095, 1895, abst J. S. C. I. 1895, **14**, 538, 787, 814.

4. E. P. 25369, 1896. See E. Lauber and R. Nehr, E. P. 21157, 1911.

5. E. P. 7386, 1897.

6. E. P. 14185, 1907.

7. E. P. 18047, 1907.

8. E. P. 5216, 1893, abst J. S. C. I. 1893, **12**, 937.

9. U. S. P. 826781, 1906, 848301, 1907.

10. E. P. 27273, 1910, 15706, 1915, abst J. S. C. I. 1916, **35**, 850, C. A. 1916, **10**, 1277.

11. U. S. P. 1023960, 1912, abst Mon. Sci. 1913, **78**, 14.

12. E. P. 27020, 1910, abst J. S. C. I. 1911, **30**, 1068, C. A. 1912, **6**, 1591.

13. L. Kurz, U. S. P. 982370, 1911. D. R. P. 234339, 1908, abst C. A. 1912, **6**, 1937.

14. U. S. P. 1253956, 1918.

15. U. S. P. 992743, 1911; 1158265, 1915, 1267445, 1918, abst C. A. 1915, **9**, 3336, 1918, **12**, 1819.

16. U. S. P. 826781, 1906; 1011443, 1911; E. P. 13005, 1906, F. P.

Anonyme Nouvelle L'Oyonnithe.¹ Nitrocotton may be substituted by gum,² resins,³ borax and shellac,⁴ alcoholic shellac,⁵ or guttapercha.⁶ Similar are the processes of W. Snelling⁷ and B. Bertelli and A. Rossi.⁸

Mother o' Pearl. In the formation of iridescent, nacreous and other lustrous versicolor and multitone changeable metallic sheens, as in the formation of mother of pearl and imitation pearl effects, the nitrocelluloses have been used for some time with pleasing effect. The older processes of C. Sticht,⁹ C. Puscher,¹⁰ J. Erfurt,¹¹ L. Clemendot,¹² A. Dietzschold,¹³ E. Flek,¹⁴ J. Jacobson,¹⁵ C. Ctibor,¹⁶ M. Bouche,¹⁷ R. Himmel,¹⁸ and Rheinische Hartgummiwaren Fabrik,¹⁹ are now primarily of but historical interest. Either gelatin,²⁰ fish glue,²¹ mica,²² especially in combination with

- 366891, 1906, abst. J. S. C. I. 1906, **25**, 1040, 1091, 1216.
17. U. S. P. 976994, 1910, 984805, 1911. Can. P. 131434, 1911.
1. F. P. 458002, 465345, 1913.
2. W. Koch, U. S. P. 1223399; abst. C. A. 1917, **11**, 1901.
3. H. Beer, U. S. P. 1023713, 1912. Metallpapier-Bronzefarben-Blattmetallwerke, A. G., D. R. P. 247356, 247898, 1910, abst. C. A. 1912, **6**, 2395, 2677.
4. E. Pratsinger, U. S. P. 859106, 1907; abst. C. A. 1907, **1**, 257. D. R. P. 189133, 1907, abst. Zts. ang. Chem. 1908, **21**, 167; Chem. Tech. Rep. 1907, **31**, 476.
5. E. and B. Holland, E. P. 9786, 1913.
6. F. Demel, U. S. P. 1076197, 1913; abst. C. A. 1914, **8**, 21. E. P. 11803, 1910; abst. J. S. C. I. 1911, **30**, 695.
7. W. Snelling, U. S. P. 1204709, 1916; abst. C. A. 1917, **11**, 211.
8. D. R. P. 247177, 1911. J. Potter, U. S. P. 1201758, 1916; abst. C. A. 1916, **10**, 3143.
9. Deut. Ind. Ztg. 1867, 166; abst. Chem. Tech. Rep. 1867, **6**, I, 65.
10. Dingl. Poly. 1867, **189**, 350; Pharm. Centralhal. 1868, **10**, 60; Chem. Tech. Rep. 1867, **6**, II, 61. Dingl. Poly. 1867, **183**, 475; Poly. Notiz. 1867, **22**, 138; Gewerbebl. 1867, 15; Indblatter, 1867, 59; Chem. Tech. Rep. 1867, **6**, I, 72.
11. Indblatter 1871, 320, Deut. Ind. Ztg. 1871, 299; Chem. Tech. Rep. 1871, **10**, II, 93.
12. E. P. 954, 1877; abst. Wag. Jahr. 1878, **24**, 577.
13. Chem. Tech. Rep. 1880, **19**, I, 184.
14. Chem. Tech. Rep. 1879, **18**, I, 151.
15. E. P. 1566, 1892.
16. Aust. P. 259, 610, 1899.
17. E. P. 3880, 1887.
18. E. P. 18413, 1891.
19. D. R. P. 32874, 1885, abst. Dingl. Poly. 1885, **258**, 428; Wag. Jahr. 1885, **31**, 1140.
20. F. Alary and A. Choisy, F. P. 328357, 1903; abst. J. S. C. I. 1903, **22**, 957.
21. K. Wirth, D. R. P. 88442, 1896; abst. Wag. Jahr. 1892, **42**, 1068; D. R. P. 119118, 1901.
22. E. Douzal, L. Davion and E. Deloume, F. P. 475760, 1915.

tin salts,¹ alkaline silicates² preferably with casein,³ are combined with pyroxylin lacquers. Bearing in mind that the colors of mother of pearl are dependent upon diffraction of light due to a grating-like structure of the terminal edges of successive laminae, and also to light interference induced by reflection from numerous parallel laminae of sensibly equal thickness,⁴ a number of methods have been devised in which fish scales are combined with nitro-cottons.

An "essence d'Orient" is prepared by the methods of C. de Vere,⁵ S. Sakane,⁶ C. Classen,⁷ J. Bock,⁸ S. Itane,⁹ L. Haudricourt,¹⁰ C. Paiseau-Feil,¹¹ G. Leroy & Co.,¹² V. & H. Hirschler,¹³ A. Zand,¹⁴ or G. Keil and K. Plischke,¹⁵ this silver lac or silver tincture being prepared by dissolving out the shiny substance from the scales by means of water, and, after the latter has been removed without drying, the multicolor mass is incorporated with pyroxylin. The scales of goldfish,¹⁶ and also the eyeball¹⁷ are said to impart the most natural effect. The addition of a small amount of ammonia¹⁸ or treatment with the vapors of titanium

1. O. Parkert, Sprechsaal, 1910, **43**, 327, abst. C. A. 1910, **4**, 2194
2. J. Rosen, E. P. 17953, 1912, abst. J. S. C. I. 1913, **32**, 790; Kunst 1913, **3**, 396
3. E. Jasset, C. Bernadac and F. Kowachelic, F. P. 458036, 1912; abst. Kunst. 1913, **3**, 476. D. R. P. 258370, 1913; abst. C. A. 1913, **7**, 2999.
4. A. Pfund, J. Frank Inst. 1917, **183**, 453, abst. C. A. 1917, **11**, 1083.
5. Pflug, E. P. 12732, 1892
6. F. P. 473382, 1913. See also F. P. 407092
7. U. S. P. 1264979, 1918; abst. C. A. 1918, **12**, 1692; J. S. C. I. 1919, **38**, 265-A
8. E. P. 6893, 1914; D. R. P. 278933, abst. C. A. 1915, **9**, 1377, 2435
9. F. P. 469017, 1913
10. Jap. P. 30572, 1916, abst. C. A. 1916, **10**, 2393
11. Belg. P. 256116, 1913. E. P. 23137, 1914
12. U. S. P. 978394, 1910. E. P. 22420, 1909, abst. C. A. 1911, **5**, 218. E. P. 23137, 1914; abst. J. S. C. I. 1919, **38**, 473-A. F. P. 407092, Add. 12922, 13035, 18507, 1909; 19255, 1913, 416696, 420885, 1909; abst. C. A. 1912, **6**, 1989. D. R. P. 222248, abst. Wag. Jahr. 1910, **56**, II, 573; 215672, 1908, 233648, 1909; abst. C. A. 1910, **4**, 682, 1911, **5**, 2745. D. R. P. Anm. P. 31992, 1913; abst. Kunst. 1914, **4**, 312.
13. F. P. 473662, 1913; Add. 20258, 1917, abst. C. A. 1918, **12**, 1112.
14. D. R. P. 201914, 1906; abst. Zts. ang. Chem. 1908, **21**, 2287.
15. U. S. P. 746909, 1903. E. P. 17827, 1903. Zapon Lack. Ges., D. R. P. 281265, 1913; abst. J. S. C. I. 1915, **34**, 500
16. D. R. P. 215672, 1908; abst. C. A. 1910, **4**, 682; Zts. ang. Chem. 1909, **22**, 2342; Chem. Zentr. 1909, **80**, II, 2054; Chem. Tech. Rep. 1909, **33**, 624; Chem. Ind. 1909, **32**, 759; Wag. Jahr. 1909, **55**, II, 557.
17. P. Perdrizet, F. P. 382603, 1906. A. Sachse & Co., Aust. P. 11204, 1903.
18. K. Seki, Jap. P. 31506, 1917; abst. C. A. 1918, **12**, 86.
19. A. Lecocq, F. P. 361562, 1905; abst. C. A. 1907, **1**, 2956.

etrachloride¹ (TiCl₄), is alleged to be especially advantageous.

Variations in procedure of the above type method, have been disclosed by Sachse & Comp.,² E. Mauvillain and V. Guillet,³ Compagnie Francaise du Celluloid,⁴ P. Castle,⁵ Erste Offenbacher Gelatine-Folien und Flitter-Fabrik Kock & Liebmann,⁶ Gesellschaft fur Gelatinierungen,⁷ J. de Jong,⁸ E. Maalouf,⁹ M. Jung-hans,¹⁰ E. Heusch.¹¹ In the manufacture of substantially spherical artificial pearls, similar methods are followed, as exemplified in the processes of J. Meyer Bros.¹² and A. Potiez.¹³ The luminosity may be enhanced by a combination of rhodamine and zinc sulfide.¹⁴ This subject has been dealt with in detail by M. de Keghel¹⁵ and A. von Unruh.¹⁶

Pyroxylin-Resin Lacquers. Combinations of various resins with the nitrocelluloses by means of solvents common to both, whereby high total-solid lacquers result, have uses multitudinous, and have been developed only as the result of long and painstaking experimentation. The preliminary preparation and treatment of the resins for maximum solubility, at the moment is of subsidiary importance in this connection. Details are to be found in the work of T. Henley,¹⁷ L. Siblet,¹⁸ D. Reed,¹⁹ F. Walton,²⁰

1. R. Michel, F. P. 455064, 1912, abst. C. A. 1914, **8**, 997.
2. D. R. P. 140521; abst. Wag. Jahr. 1903, **50**, II, 571.
3. E. P. 10983, 1914, abst. C. A. 1915, **9**, 2806. D. R. P. 278084, 1913; abst. Kunst. 1914, **4**, 336.
4. F. P. 324894, 1903.
5. E. P. 24629, 1903.
6. F. P. 437876, 1911.
7. F. P. 268570, 1913, abst. C. A. 1914, **8**, 2041; Kunst. 1914, **4**, 20.
8. U. S. P. 494255, 1893. The Presslold Co. (Can. P. 182581, 182582, 1918) combine powdered pearl shell, milk, calcium chloride, or resin, shellac or stearin.
9. F. P. 360545, 1905. See J. Rosen, E. P. 17953, 1912, for collodion containing artificial pearl manufacturing process.
10. E. P. 10896, 1902, abst. J. S. C. I. 1903, **22**, 287. F. P. 321821, 1902; 443406, 1912.
11. D. R. P. 113114, abst. Wag. Jahr. 1900, **46**, II, 585. E. Heusch and J. Paisscau, F. P. 471581, 1913; abst. J. S. C. I. 1915, **34**, 419.
12. E. P. 114619, 1918, abst. C. A. 1918, **12**, 1591. Can. P. 184065, 1918.
13. F. P. 463060, abst. Kunst. 1914, **4**, 195.
14. S. Saubermann, U. S. P. 1096644, abst. C. A. 1914, **8**, 2228.
15. Rev. chim. ind. **24**, 193; abst. C. A. 1913, **7**, 3585.
16. Kunst. 1918, **8**, 49; 1919, **9**, 136, 162, 198, 210, 222, 302; abst. G. A. 1919, **13**, 1904.
17. E. P. 2033, 1864.
18. E. P. 968, 1857.
19. E. P. 3542, 1867.
20. E. P. 2489, 1868.

E. Kunkler,¹ R. Oehmler,² J. Freeman,³ R. Vogt,⁴ I. Lamb and D. Boyde,⁵ C. Harrop,⁶ J. Kelsey,⁷ S. Challoner,⁸ C. Hodgson,⁹ J. Firth,¹⁰ H. Flemming,¹¹ W. Peel,¹² C. Jung,¹³ D. Marcus,¹⁴ L. Braine,¹⁵ C. Coffignier,¹⁶ W. Bucklin,¹⁷ E. Strange, E. Graham, and E. Burrell,¹⁸ L. Knoche and M. Issleib,¹⁹ A. and F. Kube,²⁰ G. Poulenc,²¹ H. Haensel,²² A. Tedesco,²³ A. Tixier and L. Rambaud,²⁴ G. Tuschel,²⁵ T. Minnis,²⁶ D. Chambers and H. Leaver,²⁷ G. Austerweil and P. Pipereaut,²⁸ C. Diesser,²⁹ F. Goldscheider,³⁰ F. Wachen-

- 1 E. P. 3243, 1876
- 2 U. S. P. 161148, 1875
- 3 E. P. 2322, 1880
- 4 D. R. P. 23787, 1883, abst. Wag. Jahr. 1883, **29**, 1173.
- 5 E. P. 10428, 1889
- 6 E. P. 3008, 1888
- 7 E. P. 13129, 1888
- 8 E. P. 16035, 1888, abst. J. S. C. I. 1888, **7**, 790, 1889, **8**, 719, 1890, **9**, 81
- 9 E. P. 2253, 1892, abst. J. S. C. I. 1892, **11**, 197, 389, 538
- 10 E. P. 17009, 1890, 9115, 1891, abst. J. S. C. I. 1891, **10**, 154, 593, 673, 780, 1016
- 11 E. P. 8915, 1895 D. R. P. 84146, 91810, abst. Wag. Jahr. 1895, **41**, 1075, 1897, **43**, 5
- 12 E. P. 110, 1898, abst. J. S. C. I. 1898, **17**, 93, 630, 675
- 13 E. P. 26397, 1898, abst. J. S. C. I. 1899, **18**, 502.
- 14 U. S. P. 603913, 1898, abst. Kunst. 1911, **1**, 412 E. P. 1372, 1895
- 15 E. P. 320735, 1902
- 16 Bull. Soc. Chim. 1902, **27**, 549, 1903, **29**, 551, 1905, **33**, 169, 1906, **35**, 1143, 1907, **1**, 1131, 1908, **3**, 453, 1909, **5**, 289, 1101, 1910, **7**, 1049, 1911, **9**, 549, 1914, **15**, 780, abst. J. S. C. I. 1902, **21**, 918, 1903, **22**, 808, 1905, **24**, 203, 1906, **25**, 1226, 1909, **28**, 430, 1911, **30**, 549, Chem. Centr. 1905, **76**, I, 606, 1906, **77**, II, 1262, 1907, **78**, I, 517, 1908, **79**, I, 1936, 1909, **80**, I, 1478, 1910, **81**, I, 442, 1911, **82**, I, 355, II, 289, Jahr. Chem. 1905-08, II, 3122, 1909, **62**, I, 1038, Zts. ang. Chem. 1908, **21**, 1246, 1909, **22**, 1854, J. C. S. 1909, **96**, i, 317, C. A. 1915, **9**, 972 Rev. chim. ind. 1912, **23**, 179, 1907, **18**, 111, 1918, **27**, 93, abst. C. A. 1912, **6**, 2690, 1918, **12**, 2137
- 17 U. S. P. 766167, 1904, abst. J. A. C. S. 1905, **27R**, 196
- 18 E. P. 5403, 1902, abst. J. S. C. I. 1903, **22**, 307
- 19 E. P. 16933, 1902, abst. J. S. C. I. 1903, **22**, 705.
- 20 E. P. 9591, 1904
- 21 Belg. P. 155167, 1901
- 22 Pharm. Post **35**, 715, abst. J. S. C. I. 1903, **22**, 228 B. Hansel, E. P. 23957, 1913, abst. C. A. 1915, **9**, 1123, J. S. C. I. 1914, **33**, 478
- 23 Aust. P. 17523, 1904, abst. Chem. Zts. 1904, **3**, 764
- 24 E. P. 17135, 1903, abst. J. S. C. I. 1904, **23**, 990.
- 25 U. S. P. 731723 E. P. 9983, 1899, 23155, 1901, 20933, 1902, 17451, 1903, abst. Kunst. 1911, **1**, 412, J. S. C. I. 1903, **22**, 102. See also J. S. C. I. 1902, **21**, 263
- 26 E. P. 3033, 1903
- 27 E. P. 24024, 1907
- 28 Belg. P. 216051, 1909
- 29 E. P. 16737, 1908, 11166, 1909, abst. J. S. C. I. 1909, **28**, 945
- 30 D. R. P. 165141, 1904, abst. J. S. C. I. 1906, **25**, 224.

dorf,¹ N. Welwart,² W. Weber,³ H. Terrisse,⁴ H. Thiemann,⁵ G. Jeanningros,⁶ W. Freymuth,⁷ G. Winterfeld,⁸ R. Lender,⁹ C. van Hoek,¹⁰ T. Tye,¹¹ H. Pudor,¹² K. Dietrich,¹³ J. Essner,¹⁴ H. Kunisch and G. Brunn,¹⁵ T. Pittman,¹⁶ A. Tschirch,¹⁷ A. Trivelli,¹⁸ F. Daum,¹⁹ O. Hilwitz,²⁰ Krumbhaar,²¹ Perrot,²² J. Aitken,²³ F. Fritz,²⁴ A. Zinke and H. Lieb,²⁵ F. Sperr and M. Darrin,²⁶ and P. Pooth.²⁷

Brush lacquers of high luster and great durability result from combining nitrocellulose with copal,²⁸ Venice turpentine,²⁹ sandarac,³⁰ gum-resins,³¹ logwood,³² copal varnish,³³ colophony,³⁴

1. E. P. 12460, 1905; abst. J. S. C. I. 1905, **24**, 934.
2. Chem. Ztg. 1907, **31**, 143; abst. C. A. 1907, **1**, 1065.
3. U. S. P. 840812, 1907; abst. C. A. 1907, **1**, 785.
4. Belg. P. 211568, 1908. Swiss P. 43909, 1908.
5. U. S. P. 839336, 1906; F. P. 345196, 1904; abst. J. S. C. I. 1904, **23**, 226; 1907, **26**, 264. E. P. 13180, 1905.
6. F. P. 410792, 1909.
7. E. P. 18563, 1913; abst. J. S. C. I. 1914, **33**, 325.
8. Mitt. Kgl. Materialprüfungsamt. 1912, **30**, 191; abst. J. S. C. I. 1912, **31**, 1138.
9. E. P. 21667, 1911; abst. J. S. C. I. 1912, **31**, 81. D. R. P. 277605, 1913; abst. Kunst. 1914, **4**, 300, 335.
10. Farben Ztg. 1912, **17**, 1944; abst. Kunst. 1912, **2**, 332.
11. E. P. 27579, 1911; abst. J. S. C. I. 1912, **31**, 651; C. A. 1913, **7**, 1814; Kunst. 1913, **3**, 417.
12. Zts. offentl. Chem. 1910, **16**, 315; abst. J. S. C. I. 1910, **29**, 1118.
13. Farben Ztg. **17**, 1154, 1156, 1217, 1268, 1324; abst. C. A. 1912, **6**, 2851.
14. Ann. Chim. anal. **17**, 166; abst. C. A. 1912, **6**, 2852.
15. E. P. 28491, 1910; abst. J. S. C. I. 1912, **31**, 34.
16. E. P. 21503, 1911; abst. J. S. C. I. 1912, **31**, 784.
17. Arch. Pharm. 1915, **253**, 290; abst. J. S. C. I. 1916, **35**, 129, Ann. Rep. Soc. Chem. Ind. 1916, **1**, 189.
18. U. S. P. 1205822, 1916; abst. C. A. 1917, **11**, 124.
19. Seifenseider Ztg. **39**, 641; abst. C. A. 1912, **6**, 2544.
20. Seifenseider Ztg. 1915, **42**, 625; abst. C. A. 1915, **9**, 2988.
21. Farben Ztg. 1916, **21**, 1086; abst. Zts. ang. Chem. 1916, **29**, 487-R, J. S. C. I. 1917, **36**, 395.
22. Bull. soc. pharm. 1917, **1**; Schweiz. Apoth. Ztg. 1917, **55**, 294, C. A. 1917, **11**, 2618.
23. Pharm. J. 1915, **94**, 550; abst. C. A. 1915, **9**, 1855.
24. Seifenseider Ztg. 1914, **41**, 1197; abst. C. A. 1915, **9**, 530.
25. Monatsh. 1918, **39**, 95; abst. J. S. C. I. 1918, **37**, 520-A.
26. U. S. P. 1263813, 1918; abst. J. S. C. I. 1918, **37**, 433-A.
27. Farben Ztg. **18**, 2280, 2321, 2369; **19**, 701; abst. C. A. 1913, **7**, 4081; 1914, **8**, 2070.
28. D. Smith, U. S. P. 150722, 1874.
29. P. Minor and B. Britton, E. P. 1208, 1871.
30. H. Dorr and H. Seyfert, U. S. P. 160010, 1875.
31. H. Haymen, E. P. 959, 1879.
32. J. Hyatt, U. S. P. 209570, 1878.
33. R. Cunningham, U. S. P. 225802, 1880. See Australia Appl. 2704,

turpentine,¹ rosin oil,² mastic,³ beech tar creosote,⁴ China wood oil,⁵ benzoin,⁶ shellac,⁷ rubber,⁸ shellac and aniline,⁹ blown castor oil,¹⁰ and dammar.¹¹ The resins are preferably subjected to a careful preliminary heating in order to increase their solubility, and the addition of small amounts of quinine or benzoic acid in some instances increases the hardness and enhances the luster of the film.

Other methods for pyroxylin-resin lacquer manufacture have been developed by E. Boivin,¹² W. McCaine,¹³ C. Hiron,¹⁴ B. Goldsmith,¹⁵ C. Hunter,¹⁶ T. Kelley,¹⁷ E. Crumiere et Cie,¹⁸ H. Carls and L. Ebert,¹⁹ Ward,²⁰ A. Coblenz,²¹ and J. Ferriter.²²

Pyroxylin stains for wood²³ are also used to some extent. H. Smith²⁴ has studied the action of light on colored brass lacquers. Pyroxylin resin combinations are used extensively in the coating of golf balls, as detailed in the processes of A. Powell,²⁵

- 1905, for nitrocellulose, copal, and castor oil combination
34. O. Neesen, D. R. P. 43457; abst. Wag. Jahr 1888, **34**, 1163.
1. F. Eckstein, E. P. 18932, 1892.
2. H. Bittner and C. Villedieu, E. P. 7975, 1897.
3. J. Pollock, E. P. 2568, 1896.
4. C. Jacob, U. S. P. 190865, 1877, 231675, 1880. E. P. 2181, 1878
5. W. Haller, D. R. P. 114400, 1900. Aust. P. 1394, 1900
6. J. Hubner, E. P. 16668, 1901; abst. J. S. C. I. 1902, **21**, 1216.
7. G. Reuhl, E. P. 18383, 1905.
8. British Patent Surbrite Co. and E. Meadway, E. P. 7087, 1914, abst. C. A. 1915, **9**, 2460, J. Ind. Eng. Chem. 1915, **7**, 647
9. Commercial Products Co., E. P. 402028, 1909, abst. J. S. C. I. 1909, **28**, 1212, E. P. 4154, 1909; abst. C. A. 1910, **4**, 2581
10. W. Stoddard, U. S. P. 1242491; abst. C. A. 1918, **12**, 229
11. E. Milo and E. Richardson, E. P. 20874, 1900.
12. Chem. Tech. Rep. 1877, **16**, I, 419
13. U. S. P. 217232, 1879. W. and D. McCaine, U. S. P. 286212, 1888.
14. E. P. 2841, 1884.
15. U. S. P. 463039, 1891; 490195, 1893; 615446, 1898; 631295, 1899, 1152625, 1915; abst. J. S. C. I. 1915, **34**, 1234. E. P. 19456, 1891. D. R. P. 66199; abst. Wag. Jahr. 1893, **39**, 1100.
16. E. P. 17155, 1912; abst. C. A. 1914, **8**, 424; J. S. C. I. 1913, **32**, 843.
17. E. P. 8613, 1911; abst. J. S. C. I. 1912, **31**, 595
18. F. P. 464344, 1913; abst. J. S. C. I. 1914, **33**, 480, Kunst. 1914, **4**, 236.
19. F. P. 443998, 1912.
20. E. P. Appl. 12342, 1917; abst. J. S. C. I. 1919, **38**, 519-A.
21. Rad. Gew. u. Handw. Ztg.; Schweiz. Apoth. Ztg. 1915, **53**, 65; J. pharm. chim. 1916, **13**, 81; C. A. 1916, **10**, 1797.
22. U. S. P. 1181754, 1916; abst. C. A. 1916, **10**, 1714. J. Ferriter and T. Peters, E. P. 104742, 1916; abst. C. A. 1917, **12**, 2031.
23. P. Jaeger, U. S. P. 953621, 1910. D. R. P. 220322, 1908.
24. J. S. C. I. 1901, **20**, 1188
25. E. P. 14062, 1908.

G. Lewis,¹ T. Goddard,² H. Armitage,³ J. Page,⁴ D. Macpherson,⁵ and M. Lloyd.⁶

Nitrocotton Electric Light Filaments. In the formation of "carbon" filaments for electric bulbs, W. Crookes, E. Weston,⁷ J. Swan,⁸ F. Wynne and L. Powell,⁹ laid down the principles upon which the later superstructure of this art was raised and perfected. The C. Stearn process¹⁰ employed viscose. The usual method of procedure consists in combining graphite, or the salts of the rare metals with nitrocellulose dissolved in comparatively low-boiling solvents, the solution thus formed being forced through orifices into filament form, the collodion burned off, thus leaving a fine, coherent filament of rare earth oxides. The various details of the processes proposed are to be found in the patented methods of V. Pfersdorff,¹¹ J. Bendix,¹² Cleminson Electric Lamp Attachment, Ltd., and W. King,¹³ Pharmaceutisches Institute L. W. Gans,¹⁴ V. Thomas,¹⁵ A. de Madailan,¹⁶ J. Canello,¹⁷ O. Ephrem,¹⁸ Zerning Lamp Syndicate, Ltd.,¹⁹ H. Zerning,²⁰ R. Myers,²¹ C. von Welsbach,²² and A. Plaissetty.²³

1. E. P. 2235, 1896.
2. E. P. 18233, 1895.
3. E. P. 22115, 1891.
4. E. P. 19854, 1893.
5. E. P. 14414, 1899.
6. E. P. 8201, 1891.
7. U. S. P. 264986, 264987, 264988, 1882; 304880, 1884; E. P. 4458, 1882; abst. *Electrician*, 1887, **18**, 287.
8. E. P. 4933, 1880; 5978, 1883; 3029, 1884. D. R. P. 161780.
9. E. P. 16805, 1884; abst. J. S. C. I. 1886, **5**, 172.
10. E. P. 1021, 1898. D. R. P. 108511, 1898; abst. *Mon. Sci.* 1905, **63**, 325; *Chem. Centr.* 1900, **71**, I, 1149; *Chem. Zts* 1902, **1**, 186; *Jahr. Chem.* 1900, **53**, 846; *Wag. Jahr* 1900, **46**, II, 447. E. Stern (*Zts. ang. Chem.* 1913, **24**, 806-A) has shown photomicrographs of artificial silk mantles.
11. F. P. 343080, 1904; abst. J. S. C. I. 1904, **23**, 978. D. R. P. 156063, 1904; abst. *Zts. ang. Chem.* 1905, **18**, 197.
12. D. R. P. 153346; abst. *Chem. Ztg.* 1904, **28**, 758; *Zts. ang. Chem.* 1904, **17**, 1692; *Mon. Sci.* 1905, **63**, 67.
13. E. P. 6600, 1904.
14. D. R. P. 108506, 111480; abst. *Wag. Jahr* 1900, **46**, I, 77.
15. E. P. 10703, 12160, 1900; abst. J. S. C. I. 1901, **20**, 700, 795.
16. F. P. 345012, 1904; abst. J. S. C. I. 1904, **23**, 1206.
17. F. P. 378641, 1907; abst. J. S. C. I. 1907, **26**, 1132. First Add. dated July 9, 1908, to F. P. 361602, 1905; abst. J. S. C. I. 1906, **25**, 976; 1909, **28**, 1080.
18. F. P. 383822, 1907; abst. J. S. C. I. 1908, **27**, 397.
19. E. P. 20223, 1907; abst. J. S. C. I. 1908, **27**, 1197.
20. Can. P. 122329, 1909; abst. C. A. 1909, **3**, 1497.
21. *Trans. Amer. Inst. Chem. Eng.* 1911, **3**, 172; abst. J. S. C. I. 1912,
22. *Trans. Amer. Inst. Chem. Eng.* 1911, **3**, 172; abst. J. S. C. I. 1912,
23. *Trans. Amer. Inst. Chem. Eng.* 1911, **3**, 172; abst. J. S. C. I. 1912,

Nitrocotton Incandescent Gas Mantles. Somewhat the same principle has been followed in the manufacture of incandescent gas mantles, i. e., the knitting of a stocking of nitrocotton or of cotton impregnated with the cellulose nitrates, the rare metal earths being then introduced in solution by means of solvents having dissolving power on pyroxylin (alcohol, ether, acetone, amyl acetate). The mantle thus formed is then strengthened either by immersion in paraffin or by collodionizing with an acetic acid solution of pyroxylin. Details of the various steps in connection with the development and ramifications of this important industry are to be found in the descriptions of E. Oberle,¹ L. Denayrouze,² R. Schoder,³ O. Knoßler,⁴ W. Voelker,⁵ L. Hartman,⁶ W. MacKean,⁷ J. Duncan and The New Sunlight Incandescent Company, Ltd.,⁸ J. deLevy,⁹ E. Hill,¹⁰ R. Langhans,¹¹ A. Gomess,¹² E. Hirsch,¹³ R. Eismann,¹⁴ Herterbein,¹⁵ L. Müller and J. Bonnet,¹⁶ C. Richardson,¹⁷ W. Dickson,¹⁸ J. Boullier,¹⁹

31, 20

22. U. S. P. 1086428, 1914, abst. C. A. 1914, **8**, 1241.
23. U. S. P. 683981, 1901. E. P. 26381, 1897, 9088, 1900, 20747, 1901, abst. J. S. C. I. 1901, **20**, 699, 1902, **21**, 1389. E. P. 13134, 1912. F. P. 206433, 1900, 321803, 1902; First Add. dated Sept. 9, 1902; Second Add. dated Jan. 9, 1906; abst. J. S. C. I. 1903, **22**, 291, 547, 1906, **25**, 686. D. R. P. 129013, 135534; abst. Wag. Jahr. 1902, **48**, I, 72, 1903, **49**, I, 78. Belg. P. 147946, 1900, 158179, 1901. Can. P. 83522, 1903.
 1. E. P. 12056, 1896.
 2. D. R. P. 99761; abst. Wag. Jahr. 1898, **44**, 98. E. P. 17687, 1900; abst. J. S. C. I. 1901, **20**, 976. See also A. Comes, D. R. P. 99761.
 3. E. P. 7330, 1897. O. Swete and W. Main (E. P. 6167, 1886) employ pyroxylin-coated Mexican fiber.
 4. U. S. P. 593106, 1897. E. P. 11038, 1895. D. R. P. 88556. Kunst. 1913, **3**, 20.
 5. U. S. P. 581894, 1897. E. P. 16653, 1901.
 6. U. S. P. 577187, 1897.
 7. E. P. 3493, 1898, 12077, 1899.
 8. E. P. 25359, 1899; abst. J. S. C. I. 1901, **20**, 32.
 9. D. R. P. 111387; abst. Wag. Jahr. 1900, **46**, I, 65.
 10. E. P. 13259, 1900; abst. J. S. C. I. 1901, **20**, 699.
 11. D. R. P. 53585; abst. Chem. Tech. Rep. 1890, **29**, II, 212; D. R. P. 306103, 1917; abst. J. S. C. I. 1918, **37**, 571-A.
 12. A. Gomess, D. R. P. 99616; abst. Wag. Jahr. 1898, **44**, 98, Chem. Ztg. 1898, **22**, 1017. See also H. Dobert, D. R. P. 97824, abst. Wag. Jahr. 1898, **44**, 98.
 13. D. R. P. 180047; abst. Mon. Sci. 1909, **71**, 162, Chem. Ztg. Rep. 1907, **31**, 47; Wag. Jahr. 1907, **53**, I, 72. E. P. 9864, 1905, abst. J. S. C. I. 1906, **25**, 582.
 14. D. R. P. 192666, 195312, 195313; abst. Mon. Sci. 1911, **75**, 59, Chem. Ztg. Rep. 1908, **32**, 15, 184; Jahr. Chem. 1905-08, I, 2099, Wag. Jahr. 1908, **54**, I, 96.
 15. D. R. P. 203307.
 16. D. R. P. 246464; abst. C. A. 1912, **6**, 2519; Chem. Zentr. 1912, **83**,

- A. Chenier,¹ J. Crease,² T. Terrell,³ A. Oppenheim and R. Feuer,⁴ H. Loewenthal,⁵ R. Eisenmann and J. Bendix,⁶ F. Gundy,⁷ C. Weiblen,⁸ H. Drehschmidt,⁹ J. Werthen,¹⁰ C. Thorpe and O. Dougan,¹¹ W. Bruno,¹² J. Robin,¹³ Siemens und Halske,¹⁴ A. P. White,¹⁵ Societe Lacarriere pour la Fabr. des Lampes Electriques a Incandescence,¹⁶ A. Simonini,¹⁷ British Cerofirm Co., Ltd.,¹⁸ Kreidl and Heller,¹⁹ Societe Francaise de Chaleur et Lumiere,²⁰ Drossbach & Co.,²¹ C. Bohm,²² H. Wagner,²³ A. Williams,²⁴ A. II, 167; Chem. Ztg. Rep. 1912, **36**, 329, Wag. Jahr. 1912, **58**, I, 37.
17. E. P. 6860, 1901; abst. J. S. C. I. 1901, **30**, 566.
 18. E. P. 4707, 1901; abst. J. S. C. I. 1902, **21**, 461.
 19. U. S. P. 844849, 1907. F. P. 319217, 323959, 1902; abst. J. S. C. I. 1902, **21**, 1448, 1903, **22**, 487. D. R. P. 161362; abst. Wag. Jahr. 1905, **51**, I, 114.
 1. F. P. 322258, 1902; First Add. thereto dated July 1, 1902; F. P. 330283, 1903; abst. J. S. C. I. 1903, **22**, 291, 547, 1080. D. R. P. 147761; abst. Wag. Jahr. 1904, **50**, I, 93.
 2. E. P. 454, 1902; abst. J. S. C. I. 1902, **21**, 763.
 3. E. P. 11042, 20004, 1902, 6814, 1906; abst. J. S. C. I. 1903, **22**, 619, 943. D. R. P. 199791; abst. Wag. Jahr. 1908, **54**, I, 97; Chem. Tech. Rep. 1908, **32**, 451.
 4. E. P. 27821, 1902; abst. J. S. C. I. 1903, **22**, 619. F. P. 332223, 1903; abst. J. S. C. I. 1903, **22**, 1190. D. R. P. 153758; abst. Wag. Jahr. 1906, **52**, I, 116.
 5. F. P. 338931, 1903; abst. J. S. C. I. 1904, **23**, 978.
 6. E. P. 15696, 1903; 15536, 1907; abst. J. S. C. I. 1903, **22**, 1079; 1907, **26**, 1079. F. P. 333824, 1903. D. R. P. 153346; abst. Wag. Jahr. 1905, **51**, I, 114.
 7. E. P. 10852, 1903; abst. J. S. C. I. 1904, **23**, 484.
 8. E. P. 22451, 1903; abst. J. S. C. I. 1904, **23**, 816.
 9. J. Gas Lighting, 1903, **81**, 289; abst. J. S. C. I. 1903, **22**, 289.
 10. D. R. P. 149057; abst. Wag. Jahr. 1904, **50**, I, 94. J. Gasbel. 1904, **47**, 987.
 11. E. P. 13181, 1906; abst. J. S. C. I. 1907, **26**, 309.
 12. Zts. ang. Chem. 1906, **32**, 1387; abst. J. S. C. I. 1906, **25**, 840. J. Gasbel. 1907, **50**, 298; abst. Wag. Jahr. 1907, **53**, I, 72.
 13. E. P. 25657, 1907; abst. J. S. C. I. 1909, **28**, 16.
 14. F. P. 380740, 1907; abst. J. S. C. I. 1908, **27**, 68.
 15. E. P. 3055, 1908; abst. J. S. C. I. 1908, **27**, 848.
 16. F. P. 392536, 1908; abst. J. S. C. I. 1908, **27**, 1198.
 17. E. P. 10233, 1908; abst. J. S. C. I. 1908, **27**, 932. F. P. 389876, 1908; abst. C. A. 1910, **4**, 3133.
 18. E. P. 2240, 1908; abst. J. S. C. I. 1909, **28**, 16. F. P. 386549, 1908; abst. J. S. C. I. 1908, **27**, 742. Can. P. 111677.
 19. D. R. P. Anm. T. 14290, 1909.
 20. E. P. 5262, 1910. F. P. 400378, 1909; abst. J. S. C. I. 1909, **28**, 973.
 21. D. R. P. 212842; abst. Wag. Jahr. 1909, **55**, I, 100; Chem. Tech. Rep. 1909, **33**, 467; Chem. Ind. 1909, **32**, 594.
 22. J. Gasbel. 1909, **52**, 855; abst. Wag. Jahr. 1909, **55**, I, 102. Chem. Ztg. 1909, **33**, 447; abst. J. S. C. I. 1909, **28**, 512. Zts. ang. Chem. 1912, **35**, 657; Mon. Sci. 1913, **78**, 381. J. Gas Lighting, 1913, **121**, 33, 100, 181; abst. J. S. C. I. 1913, **32**, 127. F. P. 400444, 1909; abst. J. S. C. I. 1909, **28**, 973.
 23. D. R. P. 225678; abst. Wag. Jahr. 1910, **56**, I, 82.
 24. E. P. 11459, 1910. F. P. 415980, 1910. Swiss P. 52182, 1910.

Müller,¹ J. Zdanowich,² J. Grand,³ S. Gulbrandsen,⁴ W. Bertelsmann,⁵ R. Pawlikowski,⁶ Nass,⁷ A. Weigel,⁸ H. Silberman,⁹ M. Mayer,¹⁰ J. Goosmann,¹¹ F. Breskauer,¹² and F. Wirth.¹³ Much experimentation has been done on the "toughening" of the luminiferous oxide skeleton, and it has been found that nitrocellulose used has an important bearing on this point.

Nitrocellulose in the Electrical Industries. In 1890 appeared the processes of J. Cheever,¹⁴ E. Fahrig,¹⁵ A. Ford,¹⁶ and J. Williams,¹⁷ for the employment of the p,roxyilins for insulating purposes. The next year the methods of W. Banks¹⁸ and F. Perret¹⁹ were disclosed for the covering, moulding and insulating, in which nitrocellulose formed the essential portion of the invention. This was followed—before the year 1900—by the compositions of G. Huebener,²⁰ F. Kleinstaubler,²¹ D. Hawes,²² H. Edmunds,²³ P. Ribbe,²⁴ C. Riordon,²⁵ G. Heyl-Dia,²⁶ F. Honnay and A. War-

1. E. P. 11904, 1911; abst. J. S. C. I. 1911, **30**, 1368. E. P. 431907, 1911, abst. J. S. C. I. 1911, **30**, 1446. D. R. P. 235899, 1911, 253791; abst. Wag. Jahr. 1912, **58**, I, 135, C. A. 1912, **6**, 697. Chem. Ztg. 1911, **35**, 479, abst. Wag. Jahr. 1911, **57**, I, 121.
2. E. P. 21315, 1911; abst. J. S. C. I. 1912, **31**, 1022, C. A. 1913, **7**, 1093.
3. E. P. 426156, 1911.
4. Amer. Gas Light J., 1911, 412.
5. D. R. P. 260933, 1911, abst. C. A. 1913, **7**, 3219.
6. D. R. P. 236159, 1910, abst. J. S. C. I. 1911, **30**, 1106.
7. J. Gasbel. 1911, **54**, 938. J. S. C. I. 1911, **30**, 1201. Kunst 1912, **2**, 193.
8. D. R. P. Ann. W. 38203, 1911.
9. Chem. Ztg. 1911, **35**, 1037; abst. J. S. C. I. 1911, **30**, 1201.
10. D. R. P. 312666, 1918, abst. J. S. C. I. 1919, **38**, 811-A.
11. D. R. P. 312736, 1918; abst. J. S. C. I. 1919, **38**, 811-A.
12. D. R. P. 312177, 1918, abst. J. S. C. I. 1919, **38**, 756-A.
13. D. R. P. 254496; abst. Wag. Jahr. 1912, **58**, I, 135, abst. C. A. 1913, **8**, 1095; J. S. C. I. 1913, **32**, 416. Chem. Ztg. 1911, **35**, 752. See also J. S. C. I. 1907, **26**, 863, 1272; 1908, **27**, 15, 742, 848, 932, 1909, **28**, 973, 1910, **29**, 13; 1911, **30**, 76, 609.
14. U. S. P. 431104, 1890. E. P. 10134, 1890. See also L. Requa, U. S. P. 375952, 1888.
15. E. P. 1897, 1890, abst. J. S. C. I. 1890, **9**, 232, 1891, **10**, 179.
16. E. P. 11130, 1890, abst. J. S. C. I. 1891, **10**, 706.
17. E. P. 1878, 1890; abst. J. S. C. I. 1890, **9**, 234, 436, 743, 745.
18. E. P. 17831, 1891; abst. J. S. C. I. 1892, **11**, 927.
19. U. S. P. 461272, 1891.
20. E. P. 8011, 1895; abst. J. S. C. I. 1895, **14**, 537, 709, 809.
21. E. P. 14334, 1895; abst. J. S. C. I. 1895, **14**, 786, 845, 875.
22. E. P. 1228, 1896; abst. J. S. C. I. 1896, **15**, 61, 66, 1897, **16**, 78, 82, 245.
23. E. P. 14439, 18120, 1897; 15418, 1899.
24. E. P. 26656, 1897; abst. J. S. C. I. 1897, **16**, 1061; 1898, **17**, 92.
25. E. P. 8231, 1897; abst. J. S. C. I. 1897, **16**, 380; 1898, **17**, 399.
26. E. P. 2610, 9811, 25216, 1899.

nant,¹ J. Jungbluth,² A. Smith,³ A. Lougee,⁴ and W. Colley⁵ along analogous lines.

The formation of envelopes for storage batteries,⁶ insulating submarine cables,⁷ electrical conductors,⁸ electric batteries,⁹ wire coating,¹⁰ galvanic battery electrodes,¹¹ and other electrical implements,¹² are indications of the versatility of application of the nitrocelluloses in this field. The Societe Anonyme le Carbone,¹³ General Electric Co.¹⁴ and A. Meygret¹⁵ have also contributed to this subject.

Solid Alcohol. The formation of Solid Spirit, Alcohol Cubes, 'Travelers' Alcohol, with nitrocellulose as a base is a common article of commerce. The soap combination of R. Wild was too slow burning.¹⁶ In the methods of L. Denayrouze,¹⁷ G. le Fortier,¹⁸ V. Perelzovich and G. Rosenbuch,¹⁹ J. Schaub,²⁰ F. Poulton,²¹ C. Wagner,²² alcohol is solidified by the addition of sufficient wax or paraffin, together with nitrocellulose to impart the desired quality of free burning. In this manner, cubes containing 95%-97% alcohol may be carried without alcoholic exudation. F. Bayer & Co.²³ prefer cellulose acetate to diminish the inflamma-

1. E. P. 16186, 1898, abst. J. S. C. I. 1898, **17**, 1041.
2. E. P. 9966, 18870, 1899
3. E. P. 16247, 1899, abst. J. S. C. I. 1899, **18**, 810, 967, 1029.
4. E. P. 18550, 1899
5. E. P. 15309, 1899
6. E. Sperry, U. S. P. 723329, 1903. E. P. 5569, 1900.
7. F. Tremain, E. P. 688, 1901; 5308, 1902
8. P. McGeorge, E. P. 10142, 1904.
9. L. Basset, E. P. 22236, 1908
10. J. Ledergerber and J. Bauer, Swiss P. 64329, 1913, abst. C. A. 1914, **8**, 3399.
11. V. deKaravodine, E. P. 2493, 1911, abst. Kunst 1913, **3**, 451.
12. L. Randolph, E. P. 9511, 1902
13. F. P. 321654, 1903.
14. E. P. 13383, 1905; 15171, 1907, 5416, 1908, 11544, 1915; abst. J. S. C. I. 1908, **27**, 1197; 1916, **35**, 959.
15. E. P. 22019, 1900, abst. J. S. C. I. 1900, **19**, 1172.
16. E. P. 5405, 1901; abst. J. S. C. I. 1902, **21**, 244, 1226.
17. E. P. 17687, 1900; F. P. 296132, Add. 3962, 1904; abst. J. S. C. I. 1901, **20**, 976; 1905, **24**, 420.
18. Belg. P. 195098, 1906. See also Bull. de la Soc. Fran. de Phot. 1881, **27**, 121.
19. U. S. P. 919759, 1909; E. P. 26915, 1907; F. P. 397092, 1908; abst. J. S. C. I. 1908, **27**, 826; 1909, **28**, 693; 1912, **31**, 514; C. A. 1909, **3**, 580; 1803; 1910, **4**, 3121.
20. U. S. P. 1262267, 1262268, 1918; abst. J. S. C. I. 1918, **37**, 330-A.
21. U. S. P. 1299408, 1919; abst. C. A. 1919, **13**, 1759.
22. U. S. P. 1317950, 1918; abst. C. A. 1919, **13**, 3309.
23. D. R. P. 134721, 1901; abst. Wag. Jahr. 1902, **48**, II, 456.

bility without, at the same time, impairing the speed of burning

Other Applications of the Nitrocotton Lacquers. In addition to the uses previously indicated, and which are described in detail in Volume III of this series, may be mentioned the combination with dinitrobenzene and nitroxylenes as caoutchouc substitutes;¹ filling for wheel tires;² as an ingredient in preservative paints;³ flash light composition;⁴ artificial cork manufacture;⁵ preservation of eggs;⁶ treatment of threads;⁷ waterproofing tubular articles;⁸ straw board formation;⁹ lightning bands;¹⁰ combination with cellulose;¹¹ fabrication of paper tubes;¹² producing Schreiner finish on textiles;¹³ coating sounding tubes;¹⁴ preserving natural flowers;¹⁵ waterproofing flower stems;¹⁶ metallizing lace;¹⁷ combining with native bitumens¹⁸ and the process of A. Gottschalk.¹⁹

Artificial Leather. For the purpose of this historical résumé, imitations of natural and treated skins may be conveniently divided into the four following classes: (1) Those with a simple web as a base (celluloid and pyroxylin plastic compositions); (2) those combining superimposed webs or layers united by an adhesive binder; (3) felted, fleeced or flocked vegetable or animal fibers united by binders; and (4) those produced by rolling out

1. A. Nobel, E. P. 20234, 1893, abst. Chem. Ztg. 1895, **19**, 605.
2. D. Forbes and J. Weymouth, E. P. 18864, 1896.
3. F. Fritsche & Co., E. P. 2667, 1897.
4. J. Bostwick, U. S. P. 594594, 1897.
5. A. Blumer, U. S. P. 659505, 1900, 706634, 1902.
6. E. Barlow, E. P. 11054, 1902, abst. J. S. C. I. 1902, **21**, 1090.
7. A. Samuel, F. P. 348137, 1904, abst. J. S. C. I. 1905, **24**, 438. See also A. Samuel, F. P. 348015, 1905, abst. Chem. Zts. 1905, **4**, 113, J. Soc. Dyers Col. 1905, **21**, 124, 253.
8. L. Feval, U. S. P. 769078, 1904.
9. W. Thompson, E. P. 26893, 1905.
10. C. Koch, D. R. P. 198710, abst. Wag. Jahr. 1908, **54**, 1, 157, Zts. ang. Chem. 1908, **21**, 1855.
11. R. I. huilier and L. Maurice, F. P. 405684, 1909.
12. R. Wagner and C. vonRadinger, E. P. 9240, 1909.
13. P. Kraus, U. S. P. 922295, 1909.
14. C. Munroe, Chem. Eng. **10**, 50, Chem. News, 1910, **101**, 17, C. A. 1910, **4**, 89.
15. L. Ostrander, U. S. P. 996788, 1910.
16. E. Schloss, U. S. P. 1044260, 1912. K. Roll, E. P. 1315, 1913. D. R. P. 262005, 1912; abst. C. A. 1913, **7**, 4088.
17. E. and B. Holland, E. P. 9786, 1913; abst. J. S. C. I. 1914, **33**, 642.
18. C. Forrest and J. Meigs, U. S. P. 1305790, abst. C. A. 1919, **13**, 2140.
19. F. P. 352880, 1905, abst. J. Soc. Dyers Col. 1905, **21**, 286.

thermoplastic masses.¹ We are primarily concerned in this synoptical development, with those modifications employing the cellulose esters—the nitrocelluloses.

This Section Three is divided into the following topics:

1. Pyroxylin imitation leathers (2604–2610).
2. Nitrocellulose waterproofing compositions (2610–2615).
3. Enameling of paper surfaces with cellulose nitrate (2615–2616).
4. The pyroxylin printing upon fabrics and textiles (2616–2617).
5. Pyroxylin leather, textile and paper cements (2617–2618).

A large number² of leather substitutes have embraced the

1. M. Madru, *Kunst*, 1913, **3**, 241; abst. C. A. 1913, **7**, 3248; *Collegium* 1913, 209. R. Sansome, *Textile World J.* 1917, **52**, No. 13, 27.

2. Among the more important of these may be mentioned L. Clerdent, F. P. 12651, 1851. H. Leib, F. P. 30540, 1857. A. Micaud, F. P. 31337, 1857. J. Dida, F. P. 7161, 1848. J. Codet, F. P. 20061, 1854. A. Parkes, E. P. 11147, 1846, *Repertory of Arts*, **9**, 46, 53; *Mechan. Mag.* **45**, 400. E. P. 2359, 1855; 1125, 1856, 2675, 1864; 1564, 1866; 1695, 1867. F. Abate, E. P. 1908, 1857. E. Carless, E. P. 1929, 1855. J. deClerville, E. P. 1908, 1857. J. Crook, E. P. 498, 1857. J. Destilbeaux, E. P. 231, 1856. N. Dodge, E. P. 101, 1856. J. Dricu and A. Legeay, E. P. 2604, 1859. F. East, E. P. 2849, 1855. R. Glandonati, E. P. 2951, 1858. C. Goodyear, E. P. 965, 1857. L. Guillois, F. P. 24814, 1855. W. Green, E. P. 1724, 1862, 1856; 9879, 1889. H. Jennings, E. P. 1986, 1858. W. Hall, E. P. 178, 1858. H. Hendryck, E. P. 2538, 1859. O. Henry, E. P. 1876, 1855. L. Lefevre and F. Brion, F. P. 37165, 1858. A. Legeay, E. P. 1651, 1859. J. Luis, E. P. 1651, 1859. J. deMartres, F. P. 35322, 1858. J. Paraf, F. P. 24234, 1855. L. Martres, F. P. 25823, 1855. A. Micoud, E. P. 726, 1857. A. Roger, E. P. 49, 1859. J. Rowley, E. P. 892, 1854; 1652, 1856, 2041, 1858. A. Pellet, E. P. 468, 1858. N. Szerelmey, U. S. P. 44910, 1864, Product called "Zopissa." W. Elmer, U. S. P. 38784, 38785, 1863. F. P. 54508, 1862. J. Calmer, F. P. 48127, 1861. D. Bateman, F. P. 52144, 1861. E. Gervaise, F. P. 46244, 1860. J. Abeilhau, E. P. 1403, 1862. A. Granger, E. P. 2140, 1861. A. Leverd, F. P. 47750, 1860. C. Roullier, F. P. 58135, 1863. W. Jaine, F. P. 56065, 1862. W. Nall, E. P. 2670, 1863. E. Simpson, U. S. P. 42231, 1864. U. S. P. 77993, 1868; 89055, 93102, 1869. H. Meech, U. S. P. 75690, 1868. C. Monestier and I. Bang, U. S. P. 87277, 1869. C. Salfray, U. S. P. 62503, 1867. F. Walton, U. S. P. 111100, 1871. E. P. 2489, 1868; 14830, 1890. P. Wenzel, U. S. P. 53549, 1866. H. Clark, U. S. P. 141116, 141117, 141118, 1873. L. Allen, U. S. P. 130968, 1872; 162322, 1875. J. Castkelaz and C. Depoutilly, E. P. 1879, 1871. J. Charles and C. Taylor, E. P. 1738, 1871. W. Bell, U. S. P. 153473, 1874. R. Ball, U. S. P. 210079, 210655, 1878. B. Beer, E. P. 1285, 1878. E. Floyd, E. P. 2018, 1878; *Chem. Tech. Rep.* 1879, **13**, II, 94. J. Harrington, U. S. P. 168485, 1875; Re. 7952, 1877; 220237, 1879. C. Heyl, *Chem. Tech. Rep.* 1877, **16**, I, 220. Holl. P. 1970, 1917; C. A. 1917, **11**, 2417. H. Hirtzel, D. R. P. 976, 1877. C. Kessler, D. R. P. 4976, 1878, P. deLaSala, E. P. 1552, 1879. H. Loewenberg, U. S. P. 176019, 1876. J. Noad, E. P. 1750, 1876. C. Knelles, U. S. P. 165420, 1875; 221580, 1879. J. Ryde, U. S. P. 168485, 1875. O. Sander, D. R. P. 22, 1877. K. Schwamkrug, D. R. P. 2010, 1878. A. Day, U. S. P. 210411, 1878; 322802, 322803, 322804, 322805, 1885. E. P. 36, 1878; 8786, 8787, 1885. J. Tregurtha,

• use of various vegetable and animal oils inspissated by means of

- U. S. P. 231692, 1880. W. Travis, E. P. 5191, 1884. I. Williams, U. S. P. 296263, 1884. A. vanWinkle and E. Todd, E. P. 20690, 1890. J. Wolff, D. R. P. 20483, 1882. G. Lippold, U. S. P. 242342, 1881. E. P. 5762, 1897. E. Neumann, D. R. P. 25139, 1883. W. Nash, U. S. P. 304229, 1884. G. VonNawrocki, E. P. 5341, 1880. H. Schwabacher, E. P. 44587, 1884. C. Sterlin, Chem. Tech. Rep. 1880, **19**, I, 129. V. Klein, D. R. P. 28887, 1883. S. Hurwitz, D. R. P. 17677, 1881. J. S. C. I. 1882, **1**, 239. T. Harrison, E. P. 2037, 1884. M. Grosse, U. S. P. 217365, 1881. Gripekovan & Co., Chem. Tech. Rep. 1880, **19**, I, 129. A. Glatz, D. R. P. 24177, 1883. H. Gerner, U. S. P. 229817, 1880. D. R. P. 10450, Jahr Chem. 1880, **33**, 1369; Dingl. Poly. 1880, **238**, 261; Chem. Ztg. 1880, **4**, 584. E. Fisher, U. S. P. 214872, 1881. E. Fisher and M. E. Cohn & Wollheim, E. P. 5341, 1880. C. Evans, U. S. P. 238372, 1881. A. Fell, U. S. P. 187611, 1877; 262584, 1882. D. R. P. 23192, 1882. E. Bauer, U. S. P. 277977, 1883. D. R. P. 27503, 28984, 1883. T. Alemand, E. P. 1077, 1880. H. Chase, D. R. P. 17722, 1881. H. Boston and R. Combe, E. P. 2543, 1888. A. Wilbau, E. P. 17268, 1890; 7080, 1891. C. Heep, E. P. 18730, 1889. H. Krammer, E. P. 2661, 1889. H. House, Chem. Tech. Rep. 1888, **27**, II, 126. R. Nenninger, E. P. 3665, 1886. C. Rave, E. P. 5577, 1888. W. Sochefsky, E. P. 7382, 1885. L. Waterman, E. P. 7676, 1885. T. Thomson, E. P. 3354, 1888, 3892, 1891. J. Chase, U. S. P. 507213, 1893. E. Drew, E. P. 6852, 1891. A. Ebert, E. P. 7698, 1892. A. Frampton, E. P. 16958, 1890. A. Blandy, E. P. 3591, 1889, 13864, 1890. D. R. P. 49162, Chem. Tech. Rep. 1889, **28**, II, 76. N. Kumagaya, E. P. 19481, 1893. G. Laureau, E. P. 6988, 1894. H. Krum, U. S. P. 525985, 1894. G. Sachsenröder, E. P. 15937, 1893. K. Vollmer, E. P. 3768, 1890. B. Tetweiler, E. P. 17342, 1890. C. Wittkowsky, E. P. 11381, 1886; 18989, 1890. C. Winkler, E. P. 14738, 1891. W. Sinton, E. P. 19788, 1895. J. Schweitzer, E. P. 13596, 1894. J. S. C. I. 1895, **14**, 666. Smith & MacLaurin, Ltd., Belg. P. 144867, 1899. F. Ullstein, E. P. 5657, 1895. J. Mensik, Belg. P. 133728, 1898. W. Muller, E. P. 4798, 1895. H. Mochr, Belg. P. 141090, 1899. J. Rouleau, Belg. P. 142571, 1899. A. Baldwin, E. P. 21658, 1895. F. Billing and A. Letalle, E. P. 22965, 1896. F. Hasselmann, Belg. P. 139111, 1898. M. Hocquet, E. P. 1587, 1895. J. Ker, E. P. 8069, 1896. K. Klic, E. P. 18937, 1895. J. Hertkorn, Belg. P. 137372, 1898. A. Menesdorffer, E. P. 20488, 1903. H. Moreh, U. S. P. 647979, 1900. J. Philipps, H. Lebel and R. Grimoin-Sanson, E. P. 14420, 1901. J. Philipps and P. deTrousures, E. P. 17270, 1903. H. Muller, E. P. 17979, 1904, 26593, 1908. J. S. C. I. 1909, **28**, 535. Belg. P. 178930, 1904. G. Murray, E. P. 1930, 1904; J. S. C. I. 1905, **24**, 85. F. Reddaway, E. P. 15545, 1902. E. Briggs, E. P. 3067, 3096, 1892. E. Jetter, U. S. P. 749297, 1904. E. P. 4902, 1903; J. S. C. I. 1907, **36**, 71. F. P. 330006, 1903. J. S. C. I. 1903, **22**, 1056. L. Joseph, E. P. 536, 1901. H. Karle, Belg. P. 164930, 1902, 188044, 1905. E. P. 26517, 1905; J. S. C. I. 1906, **25**, 770. F. P. 342622, 1904; Add. dated Nov. 17, 1905; J. S. C. I. 1904, **23**, 944; 1906, **25**, 488. G. and C. Falkenstein, E. P. 3062, 1901; 26596, 1902; J. S. C. I. 1903, **22**, 373. U. S. P. 667770, 1901; 714791, 1902; J. S. C. I. 1901, **20**, 731; 1903, **22**, 37. F. P. 308044, Add. 1167; J. S. C. I. 1903, **22**, 876. Belg. P. 154790, 1901; 167085, 1902. J. Ammundsen and E. Rasmussen, E. P. 11526, 1900. J. Christensen, E. P. 27041, 1902; J. S. C. I. 1903, **22**, 563. J. Cheetham and T. Southworth, E. P. 658, 1857. A. Ferraguti, Belg. P. 198137, 1907. H. Coale, F. P. 366586, 1906. J. Blenk, D. R. P. 226866, 1908; Kunst. 1911, **1**, 15; Chem. Zentr. 1910, **81**, II, 1343. L. Kennis, Belg. P. 181763, 1905. Vereinigte Kunstseidefabriken, D. R. P. 207385, 1909; Chem. Zentr. 1909, **80**, I, 1124. Societe Civile d'Etudes de l'Indechnable Grimon, Belg. P. 203256, 1907. Societe Anon. deCuirs et Courroies d'Audencarde, Belg. P. 195338, 1906. A. Thient, D. R. P. 202074; Chem. Ind. Koll. 1908, **3**, 190. L. Velasquez,

driers, with which various solid constituents were incorporated with the foregoing agglutinants. The products known as "Kamp-tulicon,"¹ "Leatherine,"² "Texol,"³ "Leatherette,"⁴ "Spongio-lignine,"⁵ "American cloth,"⁶ "Cuirette,"⁷ "Celluvert,"⁸ "Mem-

F. P. 447702; Kunst. 1913, **3**, 474. G. Winterbottom and J. Egerton, E. P. 12687, 1909; J. S. C. I. 1910, **29**, 504. C. Baj, E. P. 5077, 1911; Kunst 1912, **2**, 234; J. S. C. I. 1912, **31**, 279. G. Basler, F. P. 455787, 1913; C. A. 1913, **7**, 2497; 1914, **8**, 2277. W. Eitner and R. Kind, D. R. P. 276434, 1913; Kunst. 1914, **4**, 392. C. Gröbe, E. P. 564, 1911. F. Kremer, U. S. P. 1065691, 1913. C. A. 1914, **8**, 2638. F. P. 459440, 1913. E. Nagel, Belg. P. 254354, 1913. P. Petersen, E. P. 22644, 1913; Kunst. 1914, **4**, 345. E. Meszaros, D. R. P. 293751, 1914; J. S. C. I. 1916, **35**, 1165. E. Muskett and Rubber Substitute, Ltd., E. P. 26789, 1910; J. S. C. I. 1911, **30**, 1448; C. A. 1912, **6**, 1505. E. Rothschild, Belg. P. 225963, 1910. J. Prince, U. S. P. 1305621; C. A. 1919, **13**, 2145. W. L., and G. Ayres, E. P. 8202, 1915; J. S. C. I. 1915, **34**, 1204; C. A. 1916, **10**, 2999. A. Carlsen, F. P. 480301, 1916; C. A. 1916, **10**, 1331. Drivremmefabriken "Dana," Dan. P. 21458, 1916; C. A. 1917, **11**, 306. S. Goldreich and M. Stern & Co., E. P. 123101; C. A. 1919, **13**, 1520; J. S. C. I. 1919, **38**, 228-A. H. Broadhurst, A. Lambie, S. Peachey and The United Alkali Co., E. P. 127481, 1918; J. S. C. I. 1919, **38**, 405-A. G. Bruce, U. S. P. 1279242, 1918. C. Jung-Reinhart, D. R. P. 304096, 1916; J. S. C. I. 1918, **37**, 344-A. K. Haring, U. S. P. 1179357, 1916. H. Linne, D. R. P. Anm. L-45917, 1917; Chem. Zentr. 1919, **90**, II, 81. J. Magnin, F. P. 477767, 1915; C. A. 1916, **10**, 1585; J. S. C. I. 1916, **35**, 610. A. Meier and H. Rall, U. S. P. 1287387, 1918; J. S. C. I. 1919, **38**, 153-A. O. Reinhardt, D. R. P. 309545, 1918; Chem. Zentr. 1919, **90**, II, 74. R. Respass, U. S. P. 1276113; C. A. 1918, **12**, 2142. S. Satow, U. S. P. 1245977, 1917; J. S. C. I. 1918, **37**, 35-A; C. A. 1919, **13**, 1953. J. Schmid, Swiss P. 75980, 1918; C. A. 1918, **12**, 2142. T. Schmid and J. Foltzer, E. P. 101536; J. S. C. I. 1917, **36**, 465; C. A. 1917, **11**, 195. F. P. 482898, 1917; C. A. 1918, **12**, 236. N. Scheuer, F. P. 480809, 1916; C. A. 1916, **10**, 1332; J. S. C. I. 1917, **36**, 40. G. Spear, U. S. P. 1312758, 1919; C. A. 1919, **13**, 2579. G. Teunissen, Swiss P. 77251, 1918; C. A. 1918, **12**, 2142. J. Ward, E. P. 119304, 1917; C. A. 1919, **13**, 199. E. Wagner, Swiss P. 73105, 1916; C. A. 1917, **11**, 106. W. Spalteholz, and K. Haring, U. S. P. 1200146, 1916; D. R. P. 273652, 1911; J. S. C. I. 1914, **33**, 759, 1916, **35**, 1165. K. Spalteholz, U. S. P. 1021952, 1912, F. P. 401961, 1909; J. S. C. I. 1909, **28**, 1186; 1912, **31**, 422. O. Silberrad, E. P. 5006, 1911; abst. C. A. 1912, **6**, 2339. Skind-fabriken Unicum, K. Bendixen, P. Bendixen & Co., Aust. P. Anm. 1263/12; abst. Chem. Ztg. 1913, **37**, 32. G. Kraitschler, Aust. P. 61472; abst. Chem. Ztg. 1913, **37**, 1265. E. Reidel, Aust. P. Anm. 5603/11; abst. Chem. Ztg. 1912, **36**, 489. P. Prost and J. Girard, Belg. P. 239664, 1911; abst. Chem. Ztg. 1912, **36**, 115. H. Stassen, Belg. P. 254057; abst. Chem. Ztg. 1913, **37**, 445. R. Respass, Can. P. 191418, 1920. Canadian Consolidated Rubber Co., Ltd., Can. P. 181770, 1918. J. Campbell, D. R. P. 262709; abst. Chem. Ztg. 1913, **37**, 834. A. Somerville, U. S. P. 1337802, 1920; abst. C. A. 920, **14**, 1907. M. Chaumont, F. P. 449554; abst. Chem. Ztg. 1913, **37**, 228. J. Lipman, E. P. 12991, 1911; abst. Chem. Ztg. 1912, **36**, 752.

1. Jenne, Rept. Pat. Inv. **39**, 318.
2. M. Zingler, E. P. 3171, 1884; 8963, 1885; abst. J. S. C. I. 1885, **4**, 537.
3. A. Hutchinson, E. P. 3749, 1882.
4. E. Freely, U. S. P. 285475, 1883. E. P. 2158, 1885.
5. J. Davenport, E. P. 15872, 1885.
6. R. Gubbins and C. Farquharson, E. P. 2735, 1885; abst. J. S. C. I.

branoid,"¹ "Pantasote,"² "Perchoid,"³ "Leatherboard,"⁴ "Textiloid,"⁵ "Kerite,"⁶ "Fibroleum,"⁷ "Syrolet,"⁸ "Hide-It,"⁹ "Lin-crusta Walton,"¹⁰ "Ebonite,"¹¹ "Ecoreite,"¹² "Lucrate,"¹³ and the zinc resinate composition of G. Goldman,¹⁴ magnesian cellulose of S. Irving,¹⁵ and acetyl-albumin¹⁶ are illustrative. None of these contain the cellulose nitrates as an important ingredient.

As leather became more expensive, methods for the utilization of the small pieces and scraps were devised to simulate tanned hides, this branch of the art being reflected in the efforts of Englische Wollenwaren Manufaktur,¹⁷ C. Cole,¹⁸ A. Micoud,¹⁹ H. van den Hout,²⁰ G. Neuffer,²¹ P. Rioux and L. de Pariente,²² H. Trappes,²³ H. Bonneville,²⁴ S. Allen,²⁵ S. Dyar,²⁶ W. Burr,²⁷ L. Montier,²⁸ W. Gale 1885, **4**, 247.

7. G. Redfern, E. P. 8626, 1885, abst. J. S. C. I. 1886, **5**, 495
8. H. Morrow, E. P. 9319, 1885; abst. J. S. C. I. 1885, **4**, 514, 696, 751
1. J. Deckert, U. S. P. 487067, 1892, abst. J. A. C. S. 1892, **14**, 390
2. Pantasote Leather Co., E. P. 9769, 1891.
3. H. Hart, E. P. 2868, 2869, 1898. The "Oxolin" of C. Grist (Chem. Ztg. 1899, **23**, 705; Pharm. Centralt. 1899, **41**, 556) is similar
4. W. Jones, E. P. 6507, 1901; abst. J. S. C. I. 1901, **20**, 634
5. E. Cadoret, E. P. 12451, 1896, abst. J. S. C. I. 1896, **15**, 490, 1897, **16**, 380, 449.
6. W. Brisexy, U. S. P. 714858, 714859, 1902, 728851, 1903, abst. J. S. C. I. 1903, **22**, 34, 753
7. G. Brigalent, Das Handelsmuseum for 1900
8. W. Luxmoore, E. P. 24041, 1912, abst. J. S. C. I. 1913, **32**, 371
- J. Ind. Eng. Chem. 1913, **5**, 514
9. Hide-It Leather Co., U. S. P. 981591, 1911, E. P. 491, 1911; 14257, 1912; F. P. 425846, 1911; abst. J. S. C. I. 1911, **30**, 143, 759, Kunst. 1911, **1**, 356. D. R. P. 248592, 1911, 259666, 1912, abst. C. A. 1912, **6**, 3543, 1913, **7**, 3251, Zts. ang. Chem. 1912, **25**, 1934, Kunst. 1913, **3**, 257
10. A. Plews, E. P. 16082, 1906
11. N. Middleton, Jr., F. P. 355363, 1905
12. Ecoreite Ltd., F. P. 379150, 1907; abst. Mon. Sci. 1908, **69**, 115
13. A. Hart, U. S. P. 984665, 1911; 1131929, 1915, E. P. 13020, 1908, 11340, 1909; 18607, 1910; 3070, 18607, 1911; 18279, 1913, Belg. P. 237859, 1911; abst. C. A. 1912, **6**, 1996; 1915, **9**, 1227, J. S. C. I. 1909, **28**, 472, 1912, **31**, 280; 1914, **33**, 480; J. Soc. Dyers Color. 1912, **28**, 37
14. U. S. P. 840841, 1903, abst. C. A. 1907, **1**, 713, 793
15. U. S. P. 883442, 1908; abst. C. A. 1908, **2**, 2456
16. F. P. 316229, 1901; abst. J. S. C. I. 1902, **21**, 704
17. F. P. 316229, 1901; abst. J. S. C. I. 1902, **21**, 704
18. E. P. 3027, 1857.
19. E. P. 726, 1857.
20. E. P. 2771, 1855.
21. E. P. 1205, 1855
22. E. P. 1420, 1855.
23. E. P. 276, 1855.
24. E. P. 1001, 1864.
25. U. S. P. 40592, 40593, 1863; 69742, 1867, 73427, 80048, 1868.
26. U. S. P. 62120, 1867.
27. E. P. 689, 1869.
28. U. S. P. 73991, 1868.

and W. Boyden,¹ W. Morris,² P. Smith,³ S. Sorsen,⁴ W. Tice,⁵ Leather and Leatherette Co.,⁶ J. Stanely and T. Lemassena,⁷ E. Pollak,⁸ A. Arnold,⁹ J. Davies,¹⁰ W. Burrows,¹¹ J. Jack,¹² N. Rapeaud,¹³ E. Tuteur and W. Goulborne,¹⁴ L. Munk,¹⁵ C. Weygang,¹⁶ A. Pollak,¹⁷ G. Gautier,¹⁸ Fiber Products Co.,¹⁹ E. Reidel,²⁰ P. Damgaard,²¹ J. Doms,²² J. Campbell,²³ A. Klinger,²⁴ S. Peachey,²⁵ C. Roessler,²⁶ and M. Rigell.²⁷

H. Sichling,²⁸ K. Micksch,²⁹ H. Armin,³⁰ M. Schall³¹ and L. Andes³² have published comprehensive reviews of the methods employed.

Pyroxylin Imitation Leathers. The earlier attempts of S.

1. E. P. 3376, 1871.
2. U. S. P. 104269, 1870.
3. U. S. P. 183819, 1876.
4. D. R. P. 1694, 1877; abst. Chem. Ind. 1878, **1**, 275.
5. E. P. 2275, 1875.
6. Chem. Tech. Rep. 1879, **18**, I, 111.
7. E. P. 3141, 1884.
8. U. S. P. 270475, 1883; E. P. 146202; D. R. P. 18662; Ital. P. 13649; Aust. P. 9192, 9193, 21244, 21245.
9. E. P. 4608, 1888; abst. J. S. C. I. 1888, **7**, 363.
10. E. P. 11880, 1885; abst. J. S. C. I. 1885, **4**, 535, 616.
11. E. P. 14235, 1888; abst. J. S. C. I. 1888, **7**, 708.
12. E. P. 16155, 1887.
13. E. P. 8221, 1888; abst. J. S. C. I. 1889, **8**, 469.
14. E. P. 3027, 1887; abst. J. S. C. I. 1887, **6**, 234.
15. E. P. 11521, 1892; abst. J. S. C. I. 1893, **12**, 167.
16. E. P. 3004, 1890; abst. J. S. C. I. 1891, **10**, 556, 565.
17. E. P. 15794, 1907; abst. J. S. C. I. 1908, **27**, 170.
18. U. S. P. 736957, 1903; E. P. 19249, 1901; abst. J. S. C. I. 1902, **21**, 1405.
19. E. P. 4130, 1909; abst. J. S. C. I. 1909, **28**, 804.
20. E. P. 15761, 1911; E. P. 433281, 1911; D. R. P. 229535; Belg. P. 221556, 1909; Swiss P. 56585, 1911; abst. C. A. 1912, **6**, 694; 1913, **7**, 289; J. S. C. I. 1911, **30**, 1224; 1912, **31**, 141; Kunst. 1911, **1**, 68.
21. E. P. 22644, 1913; Belg. P. 260780; abst. Kunst. 1914, **4**, 234.
22. Belg. P. 260794; abst. Kunst. 1914, **4**, 233. See L. Andes, Kunst. 1919, **9**, 197, 216, 228, 245, 257; abst. C. A. 1920, **14**, 2276.
23. E. P. 9370, 1914; 109530, 1916; abst. C. A. 1915, **9**, 2700; J. S. C. I. 1915, **34**, 624, 1917, **36**, 1141.
24. Swiss P. 73106, 1916; abst. C. A. 1917, **11**, 306.
25. E. P. 1894, 1915; E. P. 480904, 1916; Jap. P. 32418, 1918; abst. C. A. 1916, **10**, 1950; 1917, **11**, 1338; 1918, **12**, 2249; J. S. C. I. 1916, **35**, 479; 1917, **36**, 39; Ann. Rep. Soc. Chem. Ind. 1916, **1**, 215.
26. U. S. P. 1192460, 1916; abst. C. A. 1916, **10**, 2291.
27. D. R. P. 302330, 1916; abst. J. S. C. I. 1918, **37**, 344-A.
28. Kunst. 1911, **1**, 70; Chem. Ztg. 1912, **36**, 965; C. A. 1913, **7**, 2705.
29. Kunst. 1915, **5**, 18, 41; 1918, **8**, 133, 148; abst. C. A. 1919, **13**, 1936.
30. Kunst. 1915, **5**, 133; abst. C. A. 1915, **9**, 2324.
31. Kunst. 1919, **9**, 141.
32. Kunst. 1919, **9**, 197.

Barnwell and A. Rollason,¹ L. Cornides,² P. Berard,³ J. MacIntosh,⁴ N. Petin,⁵ and G. Rhodes and J. Syme⁶ are indicative of the state of the art before 1860, these processes comprising the employment of collodion in volatile solvents for waterproofing and leather imitation purposes. The succeeding ten years witnessed the developments of T. Morris, R. Weare and E. Monckton,⁷ L. Simonet,⁸ Despaquis⁹ and W. Henley and D. Spill,¹⁰ while the period 1871-1890 brought forth the methods of L. Klopfer¹¹ which, in a small degree, contained the germ upon which modern processes have been developed.

However, the first real development along the lines of present day pyroxylin artificial leather practice was the nitrocellulose-coated Tannette produced by the Frederick Crane Chemical Co., at Short Hills, N. J., and based on the patents of W. Field.¹² This was followed by the F. Crane patent the next year¹³ which clearly set forth the principles of combining nitrocellulose with boiled or blown oils in the presence of solvents harmonious to both. The chief drawback to this product was the powerful rancid odor which developed upon long storage of the goods, and to overcome this, required many years work. The Tannette Co., combined with the Evans Artificial Leather Co., which later merged into the Boston Artificial Leather Co. The product name was then changed to Moroccoline, which is produced at Stamford, Conn., at the present time. From the date of the appearance of the W. Field patent (1892 to 1900) witnessed much activity in this art, as shown by the appearance of the processes of C. King

1. J. C. S. 1858, **11**, 85. E. P. 945, 1859, 2249, 1860.
2. E. P. 745, 1855.
3. E. P. 607, 1856; 1884, 1857, 639, 1858.
4. E. P. 2789, 1859; 1295, 1860. Reference is made to E. P. 633, 14041, 1852; 404, 1857; 2791, 1859. J. Macintosh and G. Rhodes, E. P. 734, 1859.
5. E. P. 1765, 1855.
6. E. P. 2384, 1860.
7. E. P. 2661, 1861.
8. E. P. 756, 1864.
9. Bull. Soc. Franc. Phot. 1868, **14**, 9, 285, 1873, **19**, 6.
10. E. P. 1017, 1870.
11. U. S. P. 295653, 1884. E. P. 3615, 1883, abstr. J. A. C. S. 1884, **6**, 178.
12. U. S. P. 473306, 478955, 1892; 498162, 1893, 627493, 1899; E. P. 3469, 1893; abstr. J. S. C. I. 1894, **13**, 164.
13. E. P. 3345, 1891. F. Crane and J. Wellington, E. P. 14274, 1893.

and R. Jellicoe,¹ A. Nobel,² the Velvrl patents,³ Soc. Anon. A. Roudillon et Cie,⁴ D. Sutherland and W. McLaren,⁵ A. Millar,⁶ S. Heimann,⁷ E. Heberlein,⁸ and E. Kingscote.⁹ These all comprized the use of the nitrocelluloses for imitative or water-proofing purposes.

The general method of manufacture of imitation leather was the application to a textile as a backing, of a plurality of coats of nitrocellulose-castor oil-pigment dopes, which was subsequently roll or plate embossed to simulate the tanned skins of various animals. At this time, blown cottonseed oil was gradually giving way to castor oil, which, although producing a leather of diminished strength, nevertheless reduced the odor to almost *nil*.

The decade 1901-1910 witnessed the disclosure of the methods of Nowotny Brothers,¹⁰ R. Piesbergen,¹¹ Societe Anonyme Le Corrioide,¹² E. Deiss,¹³ J. Guillot,¹⁴ H. Gregory,¹⁵ S. Hermann,¹⁶ S. Meers,¹⁷ S. Pianko and M. Knaster,¹⁸ O. Wawrziniok,¹⁹ R. Wee-

1. E. P. 15686, 24695, 1893; abst. Kunst. 1913, **3**, 410.
2. E. P. 20234, 1893; abst. Chem. Ztg. 1895, **19**, 605.
3. W. Reid, E. P. 3485, 1903; Aust. P. 13851, 1904; abst. J. S. C. I. 1903, **22**, 706. W. Reid and E. Earle, U. S. P. 568877, 1896; E. P. 21995, 1895; 56677, 1897; 26893, 1898; D. R. P. 96365; abst. Chem. Centr. 1898, **69**, I, 1220; Wag. Jahr. 1898, **44**, 1197. Can. P. 52042, 1896; Aust. P. 705, 1896. W. Reid and The Velvrl Co., E. P. 1609, 1900; 13306, 1903; abst. J. S. C. I. 1904, **23**, 670, 830. F. P. 304286, 1900; 341407, 1904; D. R. P. 103726, 168359; Can. P. 61147, 61157, 1897; abst. Wag. Jahr. 1899, **44**, 1152; Jahr Chem. 1905-08, II, 574. Velvrl Co., Ltd., and J. Howkins, E. P. 13306, 27202, 1903; abst. J. S. C. I. 1904, **23**, 670. W. Reid, Elec. Rev. 1895, **35**, 389; abst. Chem. Ind. 1895, **18**, 972.
4. E. P. 2584, 1898; abst. J. S. C. I. 1899, **18**, 259.
5. E. P. 28613, 1897; abst. J. S. C. I. 1897, **16**, 1013, 1025. D. Sutherland, E. P. 16156, 1912.
6. E. P. 17549, 1898; abst. J. S. C. I. 1898, **17**, 895; 1899, **18**, 1014.
7. U. S. P. 547120, 1895.
8. E. P. 13198, 1896; 17302, 1897; 27529, 1898; abst. J. S. C. I. 1899, **18**, 94, 98, 320, 366.
9. E. P. 10432, 1898; D. R. P. 113566, 1900; Can. P. 63574, 1899; abst. Wag. Jahr. 1900, **46**, II, 1567.
10. Aust. P. 8442, 1902.
11. E. P. 15269, 1904; F. P. 344787, 1904; Belg. P. 179220, 1904; abst. J. S. C. I. 1904, **23**, 906, 1155.
12. Belg. P. 149052, 1900.
13. E. P. 5887, 1903. See also G. de Moutlord, U. S. P. 928235.
14. F. P. 362170, 1905; abst. C. A. 1907, **1**, 1501; J. S. C. I. 1906, **25**, 647.
15. U. S. P. 848301, 1907. See also B. Goldsmith, U. S. P. 772993, 1904.
16. U. S. P. 855708, 1907; 1008332, 1911; abst. C. A. 1912, **6**, 301.
17. U. S. P. 837700, 1906; 1235043, 1917; E. P. 18499, 1906; F. P. 369220, 1906; Belg. P. 194268, 1906; Can. P. 102824, 1907; abst. J. S. C. I. 1907, **26**, 106, 160, 1022.
18. E. P. 28743, 1907; 7580, 1908; abst. J. S. C. I. 1908, **27**, 459; 1909,

ber,¹ Schuhfabrik Bonndorf Geb. Krieche,² L. Guilleateau,³ J. Guillot.⁴

G. May⁵ and W. Grosvener⁶ devised a method of partial recovery of solvent which has been applied on a manufacturing scale with—it is understood—satisfactory results.

From 1911 to the present, advancement has consisted in a large number of comparatively unimportant improvements individually, but which in the aggregate have greatly lessened the cost of production and improved the quality. Fabrikoid, Moroccoline, Duratex, Texaderm, Marokene and Sattenole are trade names for pyroxylin artificial leathers at present produced in the United States, at a total estimated daily output of approximately 28,000 square yards. Among the later processes which merit mention may be included those of E. Taylor,⁷ Societe Anonyme Nouvelle L'Oyonnithe,⁸ Suberit-Fabrik,⁹ H. Carlo,¹⁰ E. I. Du dont de Nemours Co.,¹¹ E. Delahaye,¹² E. Girzik,¹³ P.

28, 535. F. P. 385900, 1908; First Add. Mar. 9, 1908. D. R. P. 225762, 1907; abst. Kunst. 1913, **3**, 337. Swiss P. 43476, 1907. Belg. P. 204839, 1907. Can. P. 117461, 123655, 1910.

19. U. S. P. 1141224, 1915; abst. C. A. 1915, **9**, 2162. D. R. P. 228421, 238252, 1909; 246413, 1910; abst. C. A. 1912, **6**, 2191, 2504, Zts. ang. Chem. 1911, **24**, 2040; Kunst. 1911, **1**, 45.

1. U. S. P. 927198, 1909; 1186052, 1916; E. P. 15253, 1907; abst. J. S. C. I. 1908, **27**, 581; 1916, **35**, 834. Belg. P. 201657, 1907.

2. E. P. 12174, 1908; Swiss P. 42533, 1908; Belg. P. 208443, 1908. F. P. 390922.

3. F. P. 375564, 1907; abst. C. A. 1909, **3**, 261.

4. F. P. 362170, 1906; abst. Mon. Sci., 1907, **67**, 37.

5. G. May and W. Grosvener, U. S. P. 1075586, 1913; E. P. 10795, 1909; 15256, 1913; F. P. 403520, 1909; D. R. P. 244834, 257572, 1909; abst. C. A. 1912, **6**, 2537; 1913, **7**, 2691; 1915, **9**, 149, Kunst. 1913, **3**, 40; J. S. C. I. 1910, **29**, 84; 1913, **32**, 1056.

6. U. S. P. 979781, 1076976, 1913; 1186477, 1916, abst. J. S. C. I. 1913, **32**, 1104; 1916, **35**, 853. F. P. 403520, abst. J. S. C. I. 1910, **29**, 84.

7. U. S. P. 1025217, 1912; abst. C. A. 1912, **6**, 1963.

8. F. P. 473380, 1913; abst. J. S. C. I. 1915, **34**, 501.

9. D. R. P. Anm. S. 34117, 1911. See also C. Rossler, Can. P. 201885.

10. D. R. P. 254193; F. P. 443998, abst. C. A. 1913, **7**, 1084; Wag. Jahr. 1912, **58**, II, 621; Kunst. 1913, **3**, 55, 114, 176.

11. U. S. P. 1257756, 1257785, 1269339, 1918, abst. J. S. C. I. 1918, **37**, 709-A; 1919, **38**, 319-A. E. P. 122677, 122679, 122680, 122681, 126750, 1919; abst. J. S. C. I. 1919, **38**, 121-A, 394-A, 460-A, 473-A. Can. P. 178878, 178879, 178880, 189318, 189319, 189320, 189321, 201913. F. P. 488991, 488993, 488994; abst. Rev. gen. ind. Text. 1919, **4**, 57; Chem. Zentr. 1920, **91**, II, 347.

12. E. P. 14943, 1911; F. P. 418543, 1910; abst. C. A. 1913, **7**, 289; Kunst. 1913, **3**, 91, 114. Can. P. 136785, 1911, Swiss P. 57059, 1911; Aust. P. 56026; abst. Kunst. 1913, **3**, 56.

13. E. P. 4668, 1914; abst. C. A. 1915, **9**, 2152; J. S. C. I. 1914, **33**, 558. D. R. P. 281304, 286120, 1913; abst. C. A. 1915, **9**, 202, 2153; Kunst.

Braun,¹ K. Hartmann,² F. Heinker,³ E. Kempshall,⁴ J. and M. McPhie,⁵ R. McLaurin,⁶ M. Poto,⁷ C. Arnold,⁸ R. Dyer,⁹ The Duratex Co.,¹⁰ R. Dunwody and J. Wills,¹¹ D. Frothingham,¹² R. Brightman,¹³ C. Forrest and J. Meigs,¹⁴ W. Masland,¹⁵ W. Richards,¹⁶ F. Sparre,¹⁷ M. Scheuer,¹⁸ W. Stoddard,¹⁹ E. Weinheim,²⁰ A. Whitmore,²¹ and T. Turner.²²

A general résumé of pyroxylin artificial leathers has been

1914, **4**, 220, 396; 1915, **5**, 84; Chem. Zentr. 1914, **85**, I, 228. Aust. P. 3034, 1913; Holl. P. 2040, 1917; abst. C. A. 1914, **8**, 2229; 1917, **12**, 2722.

1. D. R. P. 275463, 1913; abst. C. A. 1915, **9**, 162; Kunst. 1914, **4**, 255.

2. U. S. P. 1016407, 1912; abst. Mon. Sci. 1913, **78**, 15. E. P. 16810, 1911; 29997, 1912; abst. C. A. 1913, **7**, 289; 1914, **8**, 2084; J. S. C. I. 1912, **31**, 82. D. R. P. 244566, 1910; Can. P. 137314, 1911; abst. C. A. 1912, **6**, 2339; Zts. ang. Chem. 1912, **25**, 798.

3. D. R. P. 241292, 1911. See also Deutsche Gaslühlicht Akt.-Ges. D. R. P. 256407, 262022.

4. U. S. P. 964524, 1910. E. P. 7824, 1914. See also L. Cavanaugh, Can. P. 190799, 1920.

5. E. P. 4214, 1913. See A. McLennan, New Zealand P. 33654, 1913.

6. U. S. P. 1130619, 1915; E. P. 27969, 1911; abst. C. A. 1913, **7**, 1990; 1915, **9**, 1133; J. S. C. I. 1912, **31**, 597.

7. E. P. 480939, 1916; abst. J. S. C. I. 1917, **36**, 151.

8. U. S. P. 1195431, 1916; 1247610, 1917; 1257665, 1277528, 1918, Can. P. 178879, 1917; E. P. Appl. 1180, 1182, 1183, 1918; abst. J. S. C. I. 1916, **35**, 1057; 1918, **37**, 66-A, 315-A, 709-A; C. A. 1918, **12**, 237.

9. U. S. P. 1308231, 1919; abst. C. A. 1919, **13**, 2299.

10. U. S. P. 1190806, 1190807, 1916; E. P. 102114, 106336, 1916; F. P. 481900, 481901, 1917; Swiss P. 73286, 73287; abst. C. A. 1917, **11**, 306, 546, 2624, 3465; J. S. C. I. 1916, **35**, 935, 1267; 1917, **36**, 727. Can. P. 172576, 1916.

11. U. S. P. 1187890, 1916; abst. C. A. 1916, **10**, 2155; J. S. C. I. 1916, **35**, 887.

12. U. S. P. 1316783; abst. C. A. 1919, **13**, 3011. M. Zignone, E. P. 141712, 1919.

13. J. S. C. I. 1917, **36**, 984. See also L. Lilienfeld, Aust. P. 61055, 1913; Span. P. 55263; E. P. 28210, 1912.

14. U. S. P. 1305790, 1919; abst. C. A. 1919, **13**, 2140.

15. U. S. P. 1267785, 1918. See also L. Lilienfeld, Aust. P. Ann. 2988, 1912; abst. Chem. Ztg. 1913, **37**, 596.

16. U. S. P. 1270055, 1918; abst. C. A. 1918, **12**, 1935; J. S. C. I. 1918, **37**, 709-A.

17. U. S. P. 1257756, 1266073, 1918; 1301187, 1919; abst. C. A. 1918, **12**, 1700; 1919, **13**, 1953; J. S. C. I. 1918, **37**, 315-A; 1919, **38**, 459-A.

18. U. S. P. 1291180, 1919; abst. C. A. 1919, **13**, 1030; J. S. C. I. 1919, **38**, 331-A.

19. U. S. P. 1190806, 1190807, 1916; 1262132, 1262133, 1918; abst. J. S. C. I. 1916, **35**, 935; C. A. 1918, **11**, 1604.

20. U. S. P. 1242622, 1917; 1263174, 1918; abst. C. A. 1918, **12**, 236, 1604.

21. U. S. P. 1244567, 1917; abst. C. A. 1918, **12**, 236. H. Haon, U. S. P. 1322786; abst. C. A. 1920, **14**, 365.

22. U. S. P. 1269339, 1918; abst. C. A. 1918, **12**, 1842; J. S. C. I. 1918, **37**, 709-A. See also H. Dreyfus, E. P. 133353, 1918; for the use of toluene-*o*-

given by R. Lauffmann,¹ E. Mosinger,² O. Kausch,³ E. Worden,⁴ and J. Wallner,⁵ while J. Lorenz⁶ has detailed the analytical methods for evaluation of dopes and solvents. The Pegamoid pyroxylin products are reviewed by G. Durst.⁷

In the impregnation of drum skins and gut strings⁸ artificial chamois,⁹ enameled leather,¹⁰ split leather,¹¹ and the sole leather compositions of Societe Petticolin,¹² W. Walden,¹³ L. Guilleateau,¹⁴ H. Köhler,¹⁵ M. Nachmann,¹⁶ F. Merriek,¹⁷ A. Armande,¹⁸ and Utz,¹⁹ all comprise some form of nitrocellulose.

The present practice of pyroxylin patent leather manufacture, is based on the developments of J. Edson,²⁰ and A. Cohn.²¹ monoethyl sulfonamide in cellulose acetate dopes, cf. Richter, *Lex. Kohlenstoffverb.* I, 1074

1. Kunst 1916, **6**, 41, 54, 66, 82, 93, 1918, **8**, 25, 85; C. A. 1916, **10**, 1286, 1331; 1917, **11**, 2741; 1919, **13**, 1952, 2778; J. S. C. I. 1917, **36**, 226, 1919, **38**, 227-A; Zts. ang. Chem. 1916, **29**, II, 520; Zts. Offentl. Chem. 1918, **24**, 212, 239; Chem. Zentr. 1919, **90**, II, 299. See also Deutsche Kunstleder A.-G., U. S. P. 1065684. W. Betty, U. S. P. 1158062. W. Stoddard, U. S. P. 1190806, 1190807. L. Camard, F. P. 417617. E. Delahaye, F. P. 418543. P. Braun, D. R. P. 275463. W. Reid, Aust. P. 18581. S. Meers, U. S. P. 837700, F. P. 369220. K. Haring, U. S. P. 1179357. J. Guillot, F. P. 362170. L. Geveart-Naert, E. P. 17253, 1900. I. Sackville, E. P. 18022, 1902. E. Delahaye, E. P. 14943, 1911. The Publishing, Advertising and Trading Syndicate, Swiss P. 13217. S. Hansel, D. R. P. 299310. J. Foltzer, U. S. P. 1295148, abst. J. S. C. I. 1919, **38**, 357-A. S. Lovell, E. P. 117068, abst. Kunst 1919, **9**, 94. H. Matheson, Can. P. 201912. E. du Pont de Nemours & Co., E. P. 122677, abst. Kunst 1919, **9**, 206. R. Lisauer, D. R. P. 84994; U. S. P. 586907.
2. Kunst. 1911, **1**, 244.
3. Kunst 1911, **1**, 3, 25, 51; 1914, **4**, 87, abst. C. A. 1914, **8**, 1885.
4. Kunst. 1912, **2**, 183, 221; abst. C. A. 1912, **6**, 2558, 2559.
5. Chem. Ztg. 1910, **34**, 22; Mon. Sci. 1913, **78**, 273.
6. J. Amer. Leather Chem. Assoc. 1919, **14**, 548; abst. C. A. 1919, **13**, 3336.
7. Kunst. 1912, **2**, 101, 124, 145; abst. C. A. 1912, **6**, 2558; Wag. Jahr 1913, **58**, II, 546.
8. A. Sax, E. P. 222, 1863.
9. L. Thiry, E. P. 9889, 1892. J. Hotherisall, E. P. 9659, 1887. Oesterreichische Pluviusin A.-G. E. P. 26188, 1906, 15792, 1907.
10. W. Adams, Jr., U. S. P. 685551, 685552, 1901. W. Adams, Jr. and H. McKay, U. S. P. 789249, 1905; abst. J. S. C. I. 1905, **24**, 627.
11. W. Smith, U. S. P. 837351, 1906; abst. J. S. C. I. 1907, **26**, 160.
12. E. P. 4369, 1902.
13. U. S. P. 656860, 1900.
14. U. S. P. 933645, 1909; E. P. 6216, 1907, F. P. 375564, 1907, Belg. P. 198563, 1907; 211028, 1908; abst. C. A. 1909, **3**, 261; J. S. C. I. 1908, **27**, 347; 1909, **28**, 1052; Mon. Sci. 1908, **69**, 146.
15. Swiss P. 75657, 1917; abst. C. A. 1918, **12**, 437.
16. Swiss P. 77238, 1918; abst. C. A. 1918, **12**, 2142.
17. U. S. P. 1203229, 1916; abst. C. A. 1917, **11**, 306.
18. E. P. 12840, 1915; abst. J. S. C. I. 1916, **35**, 1124.
19. Pharm. Zentralh. 1915, **56**, 481; abst. C. A. 1916, **10**, 986.
20. U. S. P. 289240, 289241, 289242, 289338, 290553, 1883; 297770,

The W. Wood and J. Stevens process of nitrocellulose enamel cloth¹ has been extensively commercialized. The F. Greening process² is similar.

As far back as 1856³ cork was apparently nitrated and used as a leather dressing composition. Combinations of cork and pyroxylin in the hands of the Deutsche Pluviusin A. G.,⁴ G. de Briailles,⁵ and L. Pink⁶ have been advocated for resilient plastics and impregnating mixtures, especially in the electrical industries.

In the dressing and treatment of furs, as by the processes of H. Müller,⁷ F. Canard,⁸ J. Mathias,⁹ J. Voneche and Soc. Comte and Mabut,¹⁰ S. Lister,¹¹ J. Biermann,¹² S. Lewis and A. Blumenthal,¹³ H. Egger¹⁴ and O. Feix,¹⁵ nitrocotton is indicated and has been used to a limited extent for the production of special effects.

In the formation of artificial ostrich,¹⁶ and other¹⁷ feathers;¹⁸ in the coating of ornamental feathers¹⁹ and feather products;²⁰ and in the fabrication of quill feathers,²¹ pyroxylin has been extensively used.

Nitrocellulose Waterproofing Compositions. Many²² ideas

1884; E. P. 5554, 1883; abst. J. A. C. S. 1884, **6**, 207; J. S. C. I. 1884, **3**, 477.

21. E. P. 16429, 1901; 8194, 1912; F. P. 441703, 1912; abst. J. S. C. I. 1902, **21**, 1189; 1912, **31**, 886, 1189.

1. U. S. P. 297098, 1884; 603001, 1898; abst. J. A. C. S. 1884, **6**, 204.

2. U. S. P. 401269, 1889; E. P. 8442, 1886; 5344, 1889. F. Greening and J. Frost, F. P. 184247, 1887; Belg. P. 77879, 1887.

3. A. Seithen, E. P. 2385, 1856.

4. Swiss P. 41275, 43416, 1907.

5. E. P. 3013, 1906; F. P. 364641, 1906; Belg. P. 189804, 1906; abst. J. S. C. I. 1906, **25**, 950; 1907, **26**, 65.

6. U. S. P. 1056446, 1913; E. P. 2455, 1911; D. R. P. 227918, 240563, 1911; abst. J. S. C. I. 1911, **30**, 1376; 1912, **31**, 67; C. A. 1912, **6**, 2523; 1913, **7**, 1589; Zts. ang. Chem. 1912, **25**, 48; Kunst. 1913, **3**, 334.

7. E. P. 556, 1862.

8. E. P. 2114, 1876.

9. E. P. 3766, 1875.

10. E. P. 1476, 1876.

11. E. P. 7830, 1884.

12. E. P. 4062, 1896; abst. J. S. C. I. 1896, **15**, 730.

13. E. P. 28143, 1904.

14. E. P. 6592, 1907; abst. J. S. C. I. 1907, **26**, 1247.

15. U. S. P. 783691, 1905; abst. J. A. C. S. 1905, **27R**, 593.

16. N. Garfinkle, U. S. P. 1030072, 1048145, 1912; E. P. 16681, 1912.

17. M. Schall, Kunst. 1914, **4**, 221, 387.

18. F. Hutchinson, E. P. 7491, 1907.

19. R. Wolfenstein, E. P. 11712, 1903; abst. J. S. C. I. 1904, **23**, 439.

20. M. and S. Lewinsohn, E. P. 15967, 1892.

21. M. and S. Lewinsohn, E. P. 5674, 1893.

22. Bessy Freres, E. P. 4447, 1877. W. Boeddinghaus, Jr., E. P. 20359, 1894. L. Bond, U. S. P. 820694, 1906; E. P. 21125, 1905; F. P. 358619,

have been brought forward for the waterproofing of paper and fabrics by means of oils, waxes and empyreumatic substances, which, however, are of but minor interest in this connection. The cellulose esters were used for this purpose in the early days of the art, as evidenced by the methods advocated by A. Rollason,¹ J. Lewthwaite,² A. Ely,³ T. Forster,⁴ J. and F. Jones,⁵ E. Whitehouse,⁶ G. and R. Gray,⁷ P. Minor,⁸ C. Townsend and A. Rollason,⁹ J. Wright,¹⁰ A. Starr,¹¹ W. Jack and F. Greening,¹² and C. Jacob,¹³ all in the period before 1880. Here, as elsewhere investigators were hampered by too few and too hygroscopic and low boiling solvents. The fabric finishing compositions of C. Garnier and P. Depouilly,¹⁴ H. Fox,¹⁵ Compagnie Generale de Chromolithie,¹⁶ I. Reagles,¹⁷ F. Annison,¹⁸ F. Doller,¹⁹ K. Bensinger,²⁰ and E. Fahrig,²¹

1905; abst. J. S. C. I. 1906, **25**, 313, 372. J. Brough, E. P. 2203, 1859. E. Cheney and G. Perry, U. S. P. 92704, 1869. G. and R. Clark, E. P. 5152, 1887. D. Conner, U. S. P. 92269, 1869. F. Eckstein, E. P. 18932, 1892. G. Forel, U. S. P. 1056898, 1913; E. P. 18930, 1910, F. P. 407654, 1909; abst. J. S. C. I. 1910, **29**, 504; 1911, **30**, 143. H. Grosvenor, E. P. 3447; 1872. A. Helbronner and E. Vallee, Swiss P. 44229, 1908. Cf. Swiss P. 37754. H. Henson, E. P. 232, 1863. J. Hunter, E. P. 2441, 2455, 1905; abst. J. S. C. I. 1905, **24**, 1245. X. Karcheski, U. S. P. 137451, 137452, 1873; 156886, 1874. P. Keilholtz, U. S. P. 994931, 1911. C. Krug and H. Bollert, D. R. P. 276553, 281302, 1914; abst. C. A. 1915, **9**, 730, 1834. D. Marcus, E. P. 1372, 1894. P. Morgan, U. S. P. 139017, 1873. E. Parnacott, E. P. 2070, 1871. E. Preston, E. P. 27560, 1897. C. Rauh, U. S. P. 96148, 1869. P. Roudiez, U. S. P. 131563, 1872. C. Royce, E. P. 16161, 1915; abst. C. A. 1917, **11**, 1558. H. Schmiedel, E. P. 8215, 1895. J. Smith, E. P. 6698, 1891. O. Thiele and J. Stocker, E. P. 8960, 1895.

1. E. P. 2849, 1858; 1057, 1863, 1610, 1873; Rep. Pat. Inv. 1859, **34**, 140; Poly. Centr. 1859, **25**, 1391; Dingl. Poly. 1860, **155**, 79.

2. U. S. P. 103209, 1870; E. P. 741, 1868, 1433, 1882.

3. U. S. P. 88048, 1869.

4. E. P. 1222, 1868.

5. E. P. 2542, 1865.

6. U. S. P. 91393, 1869.

7. U. S. P. 149216, 1874.

8. U. S. P. 112370, 1871.

9. E. P. 2972, 1871.

10. E. P. 1208, 1871.

11. U. S. P. 158188, 1874.

12. E. P. 718, 1879.

13. E. P. 3693, 1879.

14. E. P. 4765, 1883.

15. E. P. 3400, 1880.

16. E. P. 466, 1883; abst. J. S. C. I. 1883, **2**, 92, 418.

17. U. S. P. 311203, 1885; abst. J. A. C. S. 1885, **7**, 37.

18. U. S. P. 508497, 1893; Re. 11467, 1895, E. P. 19710, 1891, F. P. 223838, 1892; Belg. P. 101094, 1892; Can. P. 46932, 1894.

19. E. P. 6698, 1891. See also F. Greening, E. P. 5344, 1889.

20. D. R. P. 56516; abst. Wag. Jahr. 1891, **37**, 1174.

21. E. P. 1897, 1890; abst. J. S. C. I. 1890, **9**, 232, 1891, **10**, 179.

the electric insulating and waterproofing compositions of A. Oblasser and C. Theryc,¹ F. Werner,² W. Thompson,³ C. Shaw,⁴ and C. Schwamm,⁵ all employed nitrocotton in solution and usually in combination with resins and drying oils. The surfacing of rollers and spindles,⁶ formation of weatherproofing coatings for pictures,^{7,8} artificial leather upholstery,⁹ and the preservation and stiffening of woven fabrics¹⁰ are other outlets for collodion activity.

For the preservation of wooden objects,¹¹ waterproofing casks,¹² preservative coating compositions,¹³ and the ideas of L. and P. Bussy and H. Philippe,¹⁴ W. Hagelberg,¹⁵ E. Heusch,¹⁶ E. Hermet,¹⁷ A. Kennedy,¹⁸ L. Knoche,¹⁹ J. Mann,²⁰ L. Levy,²¹ H. Lüttke,²² B. Borzykowski,²³ C. Gould,²⁴ J. Hargreaves,²⁵ E. Joly,²⁶ A. Hill,²⁷ I. Kitsee,²⁸ P. Kraus and Bradford Dyers Association,²⁹

1. E. P. 19242, 1892.
2. U. S. P. 482604, 1892; E. P. 22262, 1891; Belg. P. 97197, 1891.
3. E. P. 11182, 1896; abst. J. S. C. I. 1897, **16**, 442.
4. Can. P. 62187, 1899.
5. E. P. 4631, 1899; D. R. P. 129966; abst. Wag. Jahr. 1902, **48**, II, 471.
6. F. Oliver, E. P. 4411, 10104, 10105, 1896; 633, 1897.
7. E. Pilz, D. R. P. 86740; abst. Wag. Jahr. 1896, **42**, 9.
8. A. Pope, D. R. P. 102963; abst. Wag. Jahr. 1899, **45**, II, 56.
9. A. and S. dePont, E. P. 24790, 1896; abst. J. S. C. I. 1898, **17**, 65.
10. E. Cadoret, E. P. 12451, 1896; abst. J. S. C. I. 1896, **15**, 490; 1897, **16**, 380, 449.
11. Engraved Wood, Ltd., E. P. 11182, 1896; abst. J. S. C. I. 1897, **16**, 442.
12. S. Bennett, E. P. 12693, 1896; Can. P. 58158, 1897.
13. H. Bittner and C. Villedieu, E. P. 7975, 1897; abst. J. S. C. I. 1898, **17**, 469.
14. E. P. 27534, 1897; abst. J. S. C. I. 1897, **16**, 1062; 1898, **17**, 1212; 1899, **18**, 53.
15. E. P. 25809, 1896.
16. E. P. 22391, 1899; abst. J. S. C. I. 1899, **18**, 1073; 1900, **19**, 92, 145.
17. E. P. 6473, 1895; abst. J. S. C. I. 1895, **14**, 1048, 1061.
18. U. S. P. 587096, 587097, 590842, 1897; E. P. 22205, 1897.
19. E. P. 12054, 1897; abst. J. S. C. I. 1898, **17**, 470.
20. E. P. 877, 1896. For apparatus see E. P. 19710, 1891.
21. E. P. 16632, 1904.
22. E. P. 24955, 1902; abst. J. S. C. I. 1903, **22**, 319.
23. E. P. 5413, 1907. F. P. 463400, 1913; abst. J. S. C. I. 1914, **33**, 417.
24. E. P. 2143, 1902.
25. E. P. 2569, 1900.
26. F. P. 350041, 1904; abst. Mon. Sci. 1907, **67**, 3.
27. U. S. P. 705244, 1902; E. P. 8076, 1901; F. P. 320614, 1902; 354121, 1905; abst. J. S. C. I. 1902, **21**, 912, 1074; 1903, **22**, 42.
28. U. S. P. 651364, 1900; 701357, 1902; abst. J. S. C. I. 1902, **21**, 925.
29. U. S. P. 922295, 1909; E. P. 17242, 18742, 1904; F. P. 351844, 1905; D. R. P. 212695; abst. J. S. C. I. 1905, **24**, 886; Zts. ang. Chem. 1909, **22**,

R. Kron,¹ L. Lilienfeld,² E. and W. Leuscher,³ B. Goldsmith,⁴ E. de la Grange,⁵ F. Cantu, G. Miglioretti and G. Maffei,⁶ M. de Chazelles,⁷ L. Chischin,⁸ J. Stevens and W. Wood,⁹ represent the more meritorious ideas for pyroxylin solution utilization advanced before 1905.

In the period 1906 to date have appeared, among many, suggestions for waterproofing and preserving by means of fluid nitro cotton, as disclosed by the publications of E. Clossmann,¹⁰ A. Douque,¹¹ E. Duinat,¹² F. Bayer & Co.,¹³ M. Friedländer,¹⁴ H. Bindewald,¹⁵ J. Blum,¹⁶ G. Gawlich,¹⁷ A. Hollands and A. Laundry,¹⁸ H. Pearson and Pearson's Patents, Ltd.,¹⁹ T. Ehniger and R. Panke,²⁰ E. Muller,²¹ M. Ratignier and H. Pervillac & Co.,²² J.

1860, Chem Zentr. 1909, **80**, II, 1663; Chem Ztg. Rep., 1909, **33**, 472, Chem Ind. 1909, **32**, 538, Wag. Jahr. 1909, **55**, II, 468.

1. E. P. 13112, 1902
2. U. S. P. 904269, 1908; E. P. 4597, 1906, abst. J. S. C. I. 1907, **26**, 146, 1908, **27**, 1202. U. S. P. 1036282, 1912, E. P. 25245, 1911, F. P. 436087, 1911, abst. J. S. C. I. 1912, **32**, 383, 813, 873. U. S. P. 1140174, 1915, 1217123, 1917, E. P. 28210, 1912; F. P. 456261, 1913, abst. C. A. 1914, **8**, 1886, 2277, 1915, **9**, 1856, J. S. C. I. 1913, **32**, 953; 1914, **33**, 432, 1917, **36**, 396, Kunst. 1913, **3**, 474. E. P. 14483, 1903, 592, 1907, 636, 1910, 26928, 1910; 6387, 1912, 6035, 1913; abst. J. S. C. I. 1908, **27**, 73; Kunst. 1912, **2**, 256, 1913, **3**, 411. D. R. P. 175664, 277263; abst. Zts. ang. Chem. 1907, **20**, 461, Chem Ztg. Rep. 1906, **30**, 354; Wag. Jahr. 1906, **52**, II, 444; Kunst. 1914, **4**, 316. Can. P. 150646, 1913; Aust. P. 2089, 1912, Belg. P. 255276; abst. C. A. 1913, **7**, 3845, 4095; Kunst. 1914, **4**, 14.
3. E. P. 18684, 1902, abst. J. S. C. I. 1903, **22**, 211.
4. U. S. P. 661263, 1900; 783828, 1905, 841509, 1907, 909288, 1909.
5. E. P. 16332, 1900; Belg. P. 158573, 1901, abst. J. S. C. I. 1901, **20**, 39. Rev. Prod. Chim. **44**, 325, abst. J. S. C. I. 1902, **21**, 179.
6. E. P. 1160, 1901; abst. J. S. C. I. 1902, **21**, 113.
7. E. P. 16656, 1903.
8. E. P. 18599, 1903; abst. J. S. C. I. 1904, **23**, 713.
9. U. S. P. 329093, 1885. J. Stevens, U. S. P. 612066, 612067, 612553, 615319, 1898, 621382, 622727, 1899.
10. E. P. 8618, 1907. Can. P. 110622, 1908.
11. E. P. 17449, 1909; abst. J. S. C. I. 1910, **29**, 1007.
12. F. P. 368393, 1906; abst. J. S. C. I. 1906, **25**, 1217.
13. D. R. P. 222292, 1908, abst. C. A. 1910, **4**, 2865, Chem. Zentr. 1910, **81**, II, 51.
14. E. P. 23547, 1909, abst. J. S. C. I. 1910, **29**, 539.
15. Can. P. 100547.
16. F. P. 392270, 1908; abst. C. A. 1910, **4**, 119.
17. E. P. 16199, 1909; D. R. P. 228421, 238252, abst. J. S. C. I. 1909, **28**, 420, Kunst. 1911, **1**, 74.
18. E. P. 29052, 1906.
19. E. P. 17243, 1908; 5323, 1912, D. R. P. 245504; abst. C. A. 1913, **7**, 2838; J. S. C. I. 1912, **31**, 680; Wag. Jahr. 1912, **59**, II, 506.
20. E. P. 14610, 1906.
21. D. R. P. 222777, 1909; abst. Chem. Zentr. 1910, **81**, II, 252.
22. U. S. P. 934214, 1909; 1012914, 1911; E. P. 13518, 1907; 16723.

Richardson and A. Marr,¹ C. Waite,² A. Zimmer,³ F. Pulber,⁴ A. Samuel,⁵ E. Roggenkamper,⁶ Societe anonyme des Soieries de Maransart, L. Ledue and H. Jacquemin,⁷ Societe Delannoy et Bonte,⁸ J. Wiggin,⁹ Aktien Ges. f. Anilin Fabrikation,¹⁰ Courtaulds, Ltd., and W. Gilles,¹¹ A. Chaplet,¹² R. Crepy,¹³ E. Dannhauser,¹⁴ H. Dittmar,¹⁵ W. Bladen,¹⁶ L. Bohmer,¹⁷ A. Baboin et Cie.,¹⁸ F. Golby and H. Ahrlé,¹⁹ W. Brückner,²⁰ B. Hansel,²¹ F. Hesse,²² H. Carls and C. Ebert,²³ W. Heeren,²⁴ B. Lazarus,²⁵ Manufaktur-Ges. N. N. Kenschlin,²⁶ D. MacDonald,²⁷ J. Mendess,²⁸

- *1910, abst. J. S. C. I. 1907, **26**, 1196, 1909, **28**, 1185; 1911, **30**, 1310; 1912, **31**, 67. E. P. 10673, 1911, 14732, 1913. F. P. 431090, 1910; 432185, Add. May 2, 1911, abst. Text. Color. 1912, **34**, 34, J. S. C. I. 1911, **30**, 1378; 1912, **31**, 811. D. R. P. 245706, 1911, 258471, 1910, abst. C. A. 1912, **6**, 2538; 1913, **7**, 2692. Aust. P. 33498, 1908.
1. E. P. 2611, 1905
 2. U. S. P. 874879, 1907
 3. E. P. 24006, 1909, 6519, 1910, F. P. 422763, 1910; abst. J. S. C. I. 1911, **30**, 21, 535. J. Soc. Dyers Color. 1911, **27**, 63
 4. U. S. P. 779375, 1905
 5. F. P. 348015, 1904. D. R. P. 165557, abst. Wag. Jahr. 1906, **52**, II, 452, Jahu Chem. 1905 08, II, 3192, Chem. Centr. 1906, **77**, I, 105.
 6. D. R. P. 234500, 1910, abst. C. A. 1911, **5**, 2074, Zts. ang. Chem. 1911, **24**, 1101, Chem. Zentr. 1911, **82**, I, 1617, Wag. Jahr. 1911, **57**, II, 470
 7. Belg. P. 255401, abst. Kunst. 1914, **4**, 16
 8. F. P. 430601, 1910, abst. J. S. C. I. 1911, **30**, 1378, Text. Color. 1912, **34**, 34
 9. U. S. P. 1044322, 1912, E. P. 27537, 1913, abst. C. A. 1913, **7**, 261
 10. E. P. 5633, 1911
 11. E. P. 13150, 1914, abst. J. S. C. I. 1914, **33**, 1152
 12. Chimiste, **4**, 47, 54, abst. C. A. 1913, **7**, 3232
 13. F. P. 448808, 1912, abst. C. A. 1913, **7**, 2707
 14. F. P. 452727, 1912, abst. C. A. 1913, **7**, 3668, J. S. C. I. 1913, **32**, 654, Mon. Sci. 1914, **81**, 41
 15. E. P. 2064, 1911
 16. U. S. P. 1021569, 1912; abst. C. A. 1912, **6**, 1355.
 17. D. R. P. 277490, 1913, abst. C. A. 1915, **9**, 1115
 18. F. P. 475338, 1914, abst. J. S. C. I. 1914, **35**, 42
 19. E. P. 17427, 1910
 20. E. P. 1799, 1910, abst. J. S. C. I. 1911, **30**, 280, J. Soc. Dyers Color. 1911, **27**, 185. D. R. P. 238361, 241781, 241820, abst. C. A. 1912, **6**, 1680, 2180, 2960, J. S. C. I. 1912, **31**, 227, Zts. ang. Chem. 1911, **24**, 2040, Wag. Jahr. 1911, **57**, 109, Chem. Zentr. 1911, **82**, II, 1076
 21. E. P. 23957, 1913, abst. J. S. C. I. 1914, **33**, 478
 22. U. S. P. 1065681, 1913, D. R. P. 250029, 1910; E. P. 10708, 1911; Belg. P. 227549, 1910, abst. C. A. 1912, **6**, 3542, 1913, **7**, 2869
 23. Swiss P. 60988, abst. Kunst. 1914, **4**, 54.
 24. E. P. 1138, 1914
 25. D. R. P. 247237, 1910, abst. C. A. 1912, **6**, 2689.
 26. D. R. P. 280133, 1914; abst. C. A. 1915, **9**, 1391.
 27. E. P. 714, 1914, abst. C. A. 1915, **9**, 1857.
 28. E. P. 12128, 1912; F. P. 450048, 1913; abst. 1915, **9**, 156; J. S. C. I. 1913, **32**, 360; Kunst. 1913, **3**, 475.

R. Mitchell,¹ A. Reimann,² G. Pluss,³ W. Abbott,⁴ A. Finkler,⁵ C. Forrest and J. Meigs,⁶ S. Graves,⁷ S. Lovell,⁸ M. Arosio,⁹ L. Cavanaugh,¹⁰ A. Arent,¹¹ C. Howlett,¹² P. Kraus,¹³ W. Bruckner,¹⁴ G. Oliver,¹⁵ and B. Hansel.¹⁶

The essence of originality permeating all of the above processes, is the combination of nitrocotton upon fabrics and absorbent surfaces, to take advantage to the maximum of the water-repellent, thermoplastic, and supple and tenuous properties of the inflammable cellulose esters. In their entirety, these processes form an interesting series of examples of the multiple uses to which the nitrated celluloses have been applied.

Enameled Paper. The processes as disclosed by M. Brown,¹⁷ L. Preaubert,¹⁸ E. Bush,¹⁹ L. Brown,²⁰ G. Pifer,²¹ S. Stephan,²² G. Magnasco,²³ and O. v. Redwitz²⁴ made use of no pyroxylin. W. Carpenter waterproofs paper with an alcoholic solution of celluloid;²⁵ W. Wilson and J. Story combined castor oil with the nitro cotton to increase the flexibility;²⁶ J. Kitsee²⁷ prepares grease-

- 1 U. S. P. 935675, 1909, abst. C. A. 1910, **4**, 386.
- 2 D. R. P. 257875, abst. Kunst. 1913, **3**, 174.
- 3 F. P. 456925, 1913, abst. J. S. C. I. 1913, **32**, 1120.
- 4 U. S. P. 1263186, 1918, abst. C. A. 1918, **12**, 1600.
- 5 E. P. 26079, 1913, F. P. 466911, 1913, abst. C. A. 1915, **9**, 1229, 1308.
- 6 U. S. P. 1305790, 1919, abst. C. A. 1919, **13**, 2110.
- 7 U. S. P. 1124012, E. P. 140, 1915, abst. C. A. 1915, **9**, 726, 1916, **10**, 1714.
- 8 U. S. P. 1256240, 1918, E. P. 117068, 1918, abst. C. A. 1918, **12**, 1001, 2136.
- 9 E. P. 131911, 1919, abst. C. A. 1920, **14**, 359.
- 10 E. P. 133180, 1918, abst. C. A. 1920, **14**, 355.
- 11 E. P. 132813, 1919, abst. C. A. 1920, **14**, 359.
- 12 U. S. P. 1324154, 1919, abst. C. A. 1920, **14**, 476.
- 13 U. S. P. 922295, 1909, abst. Chem. Ztg. Rep. 1909, **33**, 376.
- 14 D. R. P. 241781, abst. C. A. 1912, **6**, 2180.
- 15 E. P. 136433, 1920.
- 16 E. P. 131312, 1919, abst. C. A. 1920, **14**, 129.
- 17 U. S. P. 86639, 1869.
- 18 E. P. 11181, 1899, abst. J. S. C. I. 1900, **19**, 661.
- 19 E. P. 9634, 1895, 22674, 1898, abst. J. S. C. I. 1898, **17**, 1088, 1092.
- 20 U. S. P. 838607, 1906, abst. C. A. 1907, **1**, 653.
- 21 E. P. 28756, 1907, abst. J. S. C. I. 1908, **27**, 1220.
- 22 E. P. 7766, 1905, abst. J. S. C. I. 1906, **25**, 493.
- 23 U. S. P. 1101029, 1914; E. P. 18836, 1913, abst. J. S. C. I. 1914, **33**, 640, 746.
- 24 E. P. 14200, 1910; abst. J. S. C. I. 1911, **30**, 798.
- 25 U. S. P. 251410, 253840, 1882.
- 26 U. S. P. 340020, 352726, 1886; E. P. 6051, 1884, 4668, 1885. D. R. P. 28972; Can. P. 21473, 1885; F. P. 162965, 1884; Belg. P. 65924, 1884;

proof paper by superficially nitrating the unsized paper in continuous rolls, while C. Hellriegel¹ coats pasteboard by collodion solution centrifugally. The use of pegamoid for coating paper cartridges has been carried on for many years.² A similar process has been worked out by R. Annison and G. Oliver, who seek to improve the flexibility by the addition of glycerol.³ In embossed paper,⁴ the production of highly transparent coatings on paper⁵ and rendering paper for packing airtight,⁶ solutions of nitrocellulose have proven increasingly useful.

Printing on Fabrics with Nitrocellulose. The earliest attempt to print upon fabrics with nitrocellulose which met with any considerable degree of success, is probably the method of J. Kendall and R. Trested,⁷ disclosed in 1869. This was followed by the J. Schuhmacher,⁸ P. Reid and J. Eastwood,⁹ M. Bogert,¹⁰ and A. Finger and W. Menzel¹¹ in chronological order. The gist of these processes is the application of nitrocellulose to the fabric in solution after which the color in a solvent not antagonistic to the cellulose ester is mechanically affixed, or else a paste of nitrocellulose and color is directly applied to the surface to be coated. Being waterproof, such printing has satisfactory wearing qualities. The polka dots on socks, ornamentation of cheap fabrics, and the crushing and brocading of velvets are practical fields of usefulness, in which nitrocellulose prepared as above

Ital. P. Sept. 30, 1881, 17146/162, abst. J. A. C. S. 1886, **8**, 242

27. U. S. P. 772103, 1904, abst. J. S. C. I. 1904, **23**, 1110

1. E. P. 22186, 1899, abst. J. S. C. I. 1901, **20**, 62

2. Publishing and Trading Syndicate, Can. P. 51149, 1895, 51695, 1896; 58321, 58793, 1897. D. R. P. 89843, 92585, 1897; 93106, 94230, 112097, abst. Wag. Jahr. 1897, **43**, 1069, 1103. Jahr. Chem. 1900, **54**, 850. Cf. S. Ferenzi, Zts. ang. Chem. 1899, **12**, 53. Bornemann, Wochenbl. f. Papierfabr. 1901, **32**, 1

3. E. P. 4577, 1906, abst. J. S. C. I. 1907, **26**, 340

4. G. Moncanv, E. P. 25927, 1911

5. G. Kraemer and Kraemer & VanElsberg Ges., E. P. 26201, 1905, 11928, 1907, D. R. P. 193146, abst. J. S. C. I. 1906, **25**, 864, Wag. Jahr. 1908, **54**, 11, 483. See E. P. 25131, 1899, abst. J. S. C. I. 1901, **20**, 62. E. P. 27329, 1907

6. J. and B. Galay, E. P. 1715, 19772, 1909. D. R. P. 227966, 1909, abst. Kunst. 1911, **1**, 140. See also F. Hagh, E. P. 138226, 1920.

7. U. S. P. 86841, 1869

8. U. S. P. 220435, 1897.

9. U. S. P. 256597, 1882.

10. U. S. P. 270538, 1883

11. E. P. 15555, 1886.

has been applied by M. Gerard,¹ J. McClelland,² I. Frankenburg,³ and J. Cadgene.⁴

Pyroxylin Leather, Textile and Paper Cements. The earlier combinations of J. Cheetham and T. Southworth,⁵ T. Gillot,⁶ W. B. Woodbury,⁷ J. Drinkwater,⁸ C. Fontayne,⁹ R. Hennig,¹⁰ Pier¹¹ and A. Wurth¹² were valueless as judged by present day standards on account of the excessive volatility of the solvent portion. S. Pichler¹³ confined himself to alcohol and ether as the solvent medium, while S. Wood and Park House Dyeing Co.¹⁴ used clear celluloid in amyl acetate, alcohol and acetone. Undoubtedly this formula, intelligently manipulated, would yield excellent results. The Marsden Co. added lanolin to amyl acetate solution of nitrocellulose, but lanolin is insoluble in amyl acetate in amounts sufficient to impart distinct properties.¹⁵ J. Bonnaud¹⁶ imparted body and increased flexibility by the addition also of castor oil and copal, together with a small amount of vanillin. Why the latter, is not clear. The cloth, wood and leather cement of C. Ellis comprized celluloid, acetone and creosote.¹⁷ Similar in general respects to the above, are the formulas as put forward by P. Castle,¹⁸ E. Baquesne, A. Pionon and P. Colas-pillos,¹⁹ H. Dugour,²⁰ J. Berlaimont,²¹ The Bradford

1. E. P. 2694, 1887; abst J. S. C. I. 1888, **7**, 127
2. U. S. P. 360811, 1887
3. I. Frankenburg and C. Weber, E. P. 12367, 1893.
4. J. Cadgene, E. P. 18675, 1903, F. P. 274791, 1898; Addn. dated April 6, 1903; abst J. S. C. I. 1903, **22**, 1083, 1192
5. E. P. 653, 1857
6. E. P. 1746, 1866
7. Photo Archiv 1868, **9**, 242, abst Photo Mitth. 1868, **5**, 95, Chem Tech. Rep. 1868, **7**, II, 95.
8. E. P. 2625, 1872
9. U. S. P. 208584, 1878
10. R. Hennig, Chem. Tech. Rep. 1877, **16**, I, 298
11. Chem. Tech. Rep. 1877, **16**, I, 443
12. D. R. P. 851, 1877. See Chem. Tech. Rep. 1879, **18**, I, 158
13. E. P. 9261, 1894. G. Hagemann (E. P. 13838, 1894) uses a solution of nitrocellulose in acetone as a binder for cork powder in the production of artificial corks.
14. E. P. 3914, 1899; abst J. S. C. I. 1900, **19**, 243
15. E. P. 17602, 1897. D. R. P. 103506; abst. Jahr. Chem. 1899, **52**, 1306. Belg. P. 129702, 1897
16. U. S. P. 697790, 1902; abst J. S. C. I. 1902, **21**, 625.
17. U. S. P. 778232, 1904; abst J. S. C. I. 1905, **24**, 102
18. E. P. 2167, 1904; abst J. S. C. I. 1905, **24**, 36
19. Belg. P. 189298, 1906
20. E. P. 12556, 1907; F. P. 392505, 1908; abst C. A. 1909, **3**, 250;

Dyers' Association,¹ K. Lengfellner,² A. Lukacs,³ G. de Montlond,⁴ O. Siedentopf,⁵ P. Pontasy,⁶ Zapon Lack Ges.,⁷ Ago Lederkitt Industrie Ges.,⁸ T. Callan,⁹ S. Cooper,¹⁰ W. Crooker,¹¹ C. Higgins,¹² J. Martin,¹³ F. Rampichini,¹⁴ J. Byers¹⁵ and H. Babis.¹⁶

Coating of Leather with Cellulose Esters. The coating of hides and skins with the cellulose nitrates and acetates is comparatively a new industry, and has been developed practically within the last fifteen or twenty years.¹⁷ The earlier processes of G. Neuffer,¹⁸ H. Mueller,¹⁹ A. Clark,²⁰ F. Canard,²¹ H. Fox,²² H. Parkes,²³

J. S. C. I. 1908, **27**, 683, 1202, Mon. Sci. 1910, **73**, 107.

21. D. R. P. 233335, 1909, abst. C. A. 1911, **5**, 2475; Zts. ang. Chem. 1911, **24**, 911; J. S. C. I. 1911, **30**, 698; Chem. Zentr. 1911, **82**, 1266; Chem. Ztg. Rep. 1911, **35**, 204; Chem. Ind. 1911, **34**, 270, Wag. Jahr. 1911, **57**, 529; Kunst. 1911, **1**, 173, 415.

1. D. R. P. 212696, abst. Wag. Jahr. 1909, **55**, II, 469; C. A. 1909, **3**, 2757, Jahr. Chem. 1909, **62**, II, 1064; Zts. ang. Chem. 1909, **22**, 1860, Chem. Zentr. 1909, **80**, II, 664; Chem. Ind. 1909, **32**, 538.

2. F. P. 396814, 1908.

3. Belg. P. 195508, 1906.

4. U. S. P. 928235, 1909, abst. C. A. 1909, **3**, 2396.

5. E. P. 13516, 1908, abst. C. A. 1910, **4**, 91.

6. F. P. 447651, abst. Kunst. 1913, **3**, 176.

7. D. R. P. 281265, 1913; abst. C. A. 1915, **9**, 1850.

8. E. P. 4016, 1913; F. P. 454379, 1913; D. R. P. 276661, 1912, Aust. P. 61819, Swiss P. 64239, Belg. P. 253855, 1913; abst. C. A. 1914, **8**, 443, 1915, **9**, 714, J. S. C. I. 1913, **32**, 818; Kunst. 1913, **3**, 355, 1914, **4**, 75, 192, 236, 318.

9. Leather World, 1914, **6**, 523, abst. J. S. C. I. 1915, **34**, 41.

10. E. P. 16185, 1910, abst. C. A. 1911, **5**, 2732.

11. U. S. P. 994503, 1004537, 1911; abst. C. A. 1911, **5**, 2580; 1912, **6**, 311.

12. Leather Trades Year Book, 1914, 148, abst. J. S. C. I. 1914, **33**, 704.

13. F. P. 452342, 1912, abst. C. A. 1913, **7**, 3663; Kunst. 1913, **3**, 317.

14. E. P. 14586, 1910, 4253, 1911; 5350, 1912, 7086, 1913.

15. U. S. P. 1327197, 1920.

16. U. S. P. 1330421, 1920.

17. For general articles on this subject consult H. Borner, Kunst. 1912, **2**, 221. T. Callan, Leather World, **4**, 523, abst. C. A. 1914, **8**, 3515. W. Rittner, Gerber, **39**, 15; abst. C. A. 1913, **7**, 4094. C. Higgins, Leather Trades Year Book 1914, 148; abst. J. S. C. I. 1914, **33**, 704; C. A. 1914, **8**, 3514. Proctor, Principles of Leather Manufacture, page 7. M. Schall, Kunst. 1914, **4**, 221; abst. C. A. 1914, **8**, 2051. Chem. News, 1861, **4**, 82; 1863, **7**, 215. Watt, Leather Manufacture, 288. J. S. C. I. Ann. Rept. 1916, **1**, 234.

18. E. P. 1205, 1855.

19. E. P. 556, 1862.

20. E. P. 3766, 1875.

21. E. P. 2114, 1876.

22. E. P. 3400, 1880.

23. U. S. P. 265397, 1882, E. P. 1865, 1879, F. P. 132495, 1879; Belg. P. 56230, 1884.

J. Epstein,¹ L. Klopfer,² J. Edson,³ J. Walker and C. Wilkinson,⁴ T. Harrison,⁵ L. Waterman,⁶ P. Justice,⁷ W. Davies,⁸ O. Lindner,⁹ H. Minns,¹⁰ T. Stevens,¹¹ D. Whitefield,¹² W. Burrows,¹³ and A. Arnold¹⁴ were sporadic and non-commercial attempts made before 1890 to apply the nitrocelluloses in the preservation and ornamentation of leather.

In the nineties appeared the processes of C. Broadbeck,¹⁵ M. and S. Lewinsohn,¹⁶ W. Walters,¹⁷ P. Meissner,¹⁸ J. Biermann,¹⁹ L. Bracher,²⁰ W. Field,²¹ G. Wolff,²² A. Kennedy,²³ J. Herz,²⁴ and W. Reid and E. Earle,²⁵ which although containing some elements of the present day practices in this art, contained many serious common faults, mostly in manipulation. The advent of the hide-splitting machine at about this time whereby a single skin could be cut into three and sometimes four utilizable layers, each of the area of the original skin, added a great impetus to the pyroxylin leather coating industry, and was the most important single factor in its rapid and stable development.

The processes of A. Cohn, in 1901,²⁶ H. McKay²⁷ and O.

- 1 E. P. 6152, 1882
- 2 E. P. 3615, 1883.
- 3 U. S. P. 289241, 1883
- 4 E. P. 16224, 1884.
- 5 E. P. 2037, 1884
- 6 E. P. 7676, 1885.
- 7 E. P. 7223, 1885, abst. J. S. C. I. 1885, **4**, 422, 763; 1886, **5**, 36
- 8 E. P. 11880, 1885, abst. J. S. C. I. 1885, **4**, 535, 616; 1886, **5**, 184, 320, 1889, **8**, 809.
- 9 E. P. 3645, 1886, abst. J. S. C. I. 1887, **6**, 157.
- 10 E. P. 4218, 1886
- 11 E. P. 4833, 1887
- 12 E. P. 2123, 1887.
- 13 E. P. 14235, 1888; abst. J. S. C. I. 1888, **7**, 708, 1889, **8**, 672, 809
- 14 E. P. 4608, 1888; abst. J. S. C. I. 1888, **7**, 363
- 15 E. P. 18119, 1890; abst. J. S. C. I. 1890, **9**, 1086; 1891, **10**, 287, 540.
- 16 E. P. 15967, 1892, 5674, 1893.
- 17 E. P. 21717, 1895; abst. J. S. C. I. 1895, **14**, 1006; 1896, **15**, 636
- 18 E. P. 12870, 1896.
- 19 E. P. 4062, 1896, abst. J. S. C. I. 1896, **15**, 730
- 20 E. P. 25369, 1896.
- 21 U. S. P. 627493, 1899.
- 22 U. S. P. 632163, 1899.
- 23 U. S. P. 587097, 1897.
- 24 E. P. 758, 1897.
- 25 E. P. 26677, 1897; U. S. P. 655735, 1890.
- 26 E. P. 16429, 1901; abst. J. S. C. I. 1902, **21**, 1189.
- 27 U. S. P. 704082, 1902; abst. J. S. C. I. 1902, **21**, 1033.

Reichelt¹ the next year, and E. Jetter,² W. Blakeman³ and S. Lewin and A. Blumenthal⁴ the two following years, as well as the developments of O. Feix,⁵ W. Adams and H. McKay,⁶ Oesterreichische Pluviusin-Akt.,⁷ Patent Leather Co.,⁸ and especially S. Pianko and M. Knaster,⁹ covered the field of coating and enameling grain and split leathers with the nitrocelluloses. Elaboration in technique of these fundamental processes is to be found in the subsequent methods of L. Feval,¹⁰ H. Feldmann,¹¹ H. Fooks,¹² O. Siedentopf,¹³ C. Page and A. Urmetzer,¹⁴ L. Krajewski,¹⁵ B. Goldsmith,¹⁶ M. Ratignier,¹⁷ E. Reidel,¹⁸ M. Pianko,¹⁹ A. McLennan,²⁰ H. Koehler,²¹ G. Johnston,²² A. Junghans,²³ Hide-ite Leather Co.,²⁴ K. Hartmann,²⁵ N. Garfinkle,²⁶ A. Edlund,²⁷

1. E. P. 14122, 1902, abst. J. S. C. I. 1903, **22**, 919.
2. E. P. 4902, 1903; abst. J. S. C. I. 1904, **23**, 71.
3. U. S. P. 767682, 1904; abst. J. A. C. S. 1905, **27R**, 251.
4. E. P. 28143, 1904.
5. U. S. P. 783691, 1905.
6. U. S. P. 685551, 685552, 1901; 780240, 1905; abst. J. S. C. I. 1905, **24**, 627.
7. E. P. 26188, 1906; abst. C. A. 1908, **2**, 483.
8. E. P. 16598, 1906; F. P. 368383, 1906; abst. J. S. C. I. 1907, **26**, 265.
9. E. P. 28743, 1907, abst. J. S. C. I. 1908, **27**, 459, 7580, 1908, abst. J. S. C. I. 1909, **28**, 535, Addn. Mar. 9, 1908, to F. P. 385900, 1908, abst. J. S. C. I. 1908, **27**, 911. Belg. P. 204839, 1907; Can. P. 123655, 1910.
10. U. S. P. 848357, 1907, abst. J. S. C. I. 1907, **26**, 540.
11. E. P. 378643, 1907; abst. J. S. C. I. 1907, **26**, 1153.
12. E. P. 18047, 1907.
13. E. P. 13516, 1908, abst. C. A. 1910, **4**, 91.
14. E. P. 7088, 1909.
15. F. P. 402160, 1909, abst. J. S. C. I. 1909, **28**, 1212.
16. U. S. P. 661263, 1900; 909288, 1909, abst. C. A. 1909, **3**, 1106.
17. E. P. 11732, 1913.
18. E. P. 15761, 1911, abst. J. S. C. I. 1911, **30**, 1224; C. A. 1913, **7**, 280; F. P. 433281, 1911, abst. J. S. C. I. 1912, **31**, 141.
19. E. P. 9304, 1902, abst. J. S. C. I. 1902, **21**, 1085; E. P. 11768, 1913; abst. C. A. 1914, **8**, 3638.
20. E. P. 21081, 1912; abst. C. A. 1914, **8**, 1033.
21. Swiss P. 75657, 1917, abst. C. A. 1918, **12**, 437.
22. E. P. 18286, 1911; abst. J. S. C. I. 1912, **31**, 830.
23. F. P. 321821, 1902, abst. J. S. C. I. 1902, **22**, 287, 288; F. P. 443406, 1912; Can. P. 144658, 1912; abst. C. A. 1913, **7**, 1307; D. R. P. 253309, 1912; abst. C. A. 1913, **7**, 560.
24. D. R. P. Ann. H. 52909.
25. U. S. P. 1016407, 1912, abst. Mon. Sci. 1913, **78**, 15. E. P. 16810, 1911; 29997, 1912, abst. C. A. 1914, **8**, 2084. D. R. P. 244566, 1910; abst. C. A. 1912, **6**, 2339. Zts. ang. Chem. 1912, 798. Can. P. 137314, 1911.
26. E. P. 16881, 1912.
27. Dan. P. 22013, 1917; abst. C. A. 1917, **11**, 2161.

British United Shoe Machinery Co.,¹ G. Basler,² W. Crooker,³ Bartels, Dierichs & Co.,⁴ Badische Anilin & Soda Fabrik,⁵ S. Aguilar,⁶ P. Damgaard,⁷ and F. Rampichini,⁸ J. Byers,⁹ L. Feval,¹⁰ G. Lessard,¹¹ G. Johnston,¹² D. O'Keefe,¹³ Firm of Cornelius Heyl,¹⁴ J. McDonald,¹⁵ and W. Smith and J. Larkin.¹⁶

These being among the methods described in detail in Volume Three.

Artificial Filaments. Section Five. The subject matter embodied in the historical development of this art is comprehended under the following six headings (see p. 2381):

1. Nitrocellulose silks (2621-2626).
2. Artificial filament formation (2626-2644).
3. Artificial hemp, straw, bast and braid (2644-2646).
4. Animal silks, i. e., casein, gelatin, albuminoids (2646-2651).
5. Differentiation between various classes of filaments (2651-2652).

6. Cuprammonium filaments (2652-2655).

Nitrocellulose Silks. It was in 1881 that the first patent was issued for the manufacture of nitrocellulose filaments, being granted to H. de Chardonnet.¹⁷ Little commercial progress,

- 1 E. P. 104207, 1916; abst. C. A. 1917, **12**, 2055.
- 2 F. P. 455787, 1913; abst. C. A. 1914, **8**, 2277. See also C. A. 1913, **7**, 2497.
- 3 U. S. P. 994503, 1911; 1004537; abst. C. A. 1912, **6**, 311.
- 4 F. P. 455213, 1913; abst. C. A. 1914, **8**, 827.
- 5 E. P. 8511, 8512, 24216, 1912; abst. C. A. 1913, **7**, 3251, 1914, **8**, 1357.
- 6 U. S. P. 1121220, 1914; abst. C. A. 1915, **9**, 393.
- 7 E. P. 22644, 1913; abst. J. S. C. I. 1914, **33**, 655.
- 8 E. P. 5350, 1912; 7086, 1913.
- 9 U. S. P. 1327197, 1920; abst. J. S. C. I. 1920, **39**, 242 A, C. A. 1920, **14**, 865.
- 10 U. S. P. 847987, 1907.
- 11 Can. P. 155560, 1914.
- 12 Can. P. 141002, 1912.
- 13 Can. P. 139271, 1912.
- 14 E. P. 138130, 1920; abst. C. A. 1920, **14**, 1766.
- 15 U. S. P. 1306863, 1919; abst. C. A. 1919, **13**, 2467.
- 16 D. R. P. Anm. S-32091.
- 17 F. P. 165349, 1884, the other Chardonnet patents are F. P. 172207, 1885, 199494, 201740, 1889, 203202, 207624, 208405, 1890, 216564, 1891, 221488, 225567, 1892, 231230, 1893, 334398, 1905, 354398, 1904; 377673, 1906; abst. J. S. C. I. 1907, **26**, 1088, First addn. dated July 27, 1906, to F. P. 377673, 1906; F. P. 387054, 1908, 430445, 1910; abst. J. S. C. I. 1911 **30**, 1249. F. P. 410652, 1909; 434602, 1910; abst. J. S. C. I. 1912, **31**, 328, Kunst 1912, **2**, 175; various renewals of the foregoing, F. P. 478405, E. P. 6045, 1885; 2210, 2211, 1886; 5270, 1888, 1656, 1890; abst. J. S. C. I. 1891, **10**, 359; E. P. 53176, 1890; 19560, 24638, 1891; 24638, 1893; 1436, 1911; abst.

however, was made until after the Paris Exposition of 1889, the samples exhibited receiving a Grand Prix and exciting much curiosity and admiration. The process of F. Lehner next appeared in the field¹ and differed from the foregoing in employing less viscous solutions, projecting the solution through the capillary spinnerets at reduced pressures. The "Fismes Silk" of J. du

- C. A. 1911, **5**, 3315; J. S. C. I. 1911, **30**, 888. E. P. 10857, 10858, 1915. D. R. P. 38368, 1885; abst. Chem. Tech. Rep. 1889, **18**, I, 80; Dingl. Poly. 1887, **264**, 174; Jahr Chem 1887, **40**, 2693; Wag. Jahr. 1887, **33**, 1139. D. R. P. 46125, 1888; abst. Jahr Chem. 1889, **42**, 2840, 2860. Ber. 1888, **21**, 913; Wag. Jahr. 1889, **35**, 1132; 1890, **36**, 1103. D. R. P. 56331; abst. Chem. Tech. Rep. 1891, **20**, II, 120; Wag. Jahr. 1891, **37**, 1113; Zts. ang. Chem. 1891, **4**, 500. D. R. P. 56655; abst. Zts. ang. Chem. 1891, **4**, 466; Wag. Jahr. 1891, **37**, 1112. F. P. 354398. Can. P. 174863. D. R. P. 64031; abst. Wag. Jahr. 1892, **38**, 376. D. R. P. 81599, 1893; abst. Wag. Jahr. 1895, **41**, 955. D. R. P. 203649; abst. Wag. Jahr. 1909, **55**, II, 390; Zts. ang. Chem. 1908, **31**, 2334; Chem. Zentr. 1908, **79**, II, 1835; Chem. Ztg. Rep. 1908, **32**, 619; Chem. Ind. 1908, **31**, 715. C. A. 1909, **3**, 724. D. R. P. 231614. U. S. P. 394559, 1888, 410404, 1889, 455245, 460629, 1891, 531158, 1894, 1209133, 1243489, 1245690. Swiss P. 1958, 1890; 2123, 3667, 1891; 4412, 10506, 1895. It. P. 265, 17844, 1885; and first addn. thereto dated Jan. 5, 1887; 30780, 30856, 1891, 114759, 1911, Span. P. 7849, 1885; and Certificate of addition thereto dated Jan. 20, 1886; Belg. P. 68800, 1885; 128068, 1897; 231614, 1910. Aust. Hung. P. 31310. Aust. P. 25239. Can. P. 40117, 1892. U. S. P. 1245690, E. P. 10858, 1915; abst. J. S. C. I. 1916, **35**, 320; 1918, **37**, 6-A. See also Ber. 1887, **20**, 183. Chem. Tech. Rep. 1887, **26**, I, 97, Compt. rend. 1887, **105**, 898. J. S. C. I. 1888, **7**, 206; La Nature, 1888, I, 163. Ber. 1888, **21**, 913. Compt. rend. 1889, **108**, 961; abst. Jahr. Chem. 1889, **42**, 2840. J. S. C. I. 1889, **8**, 539. Cosmos, 1889, **14**, 149. Chem. Tech. Rep. 1889, **28**, I, 80. Uhland's W. T. **4**, 264. Mon. Sci. 1892, **36**, 50. Ind. Text. 1893, **9**, 175, 1897, **13**, 66. Ber. 1895, **28**, 709. Chem. Tech. Rep. 1895, **34**, II, 127. L'Ind. Text. 1909, 91; abst. J. Soc. Dyers Col. 1909, **25**, 250. Kunst. 1912, **2**, 196. Rev. Gen. mat. Color. **14**, 336. Ch. de Kirivan, Cosmos, 1889, **14**, 171. H. Wyss, Leip. Farb. Ztg. 1898, (9), **47**, 399. Pap. Ztg. 1898, **23**, 3824, 3863. J. S. C. I. 1887, **6**, 139; 1888, **7**, 206; 1889, **8**, 539, 611; 1890, **9**, 286; 1891, **10**, 359; 1895, **14**, 267; 1898, **17**, 918. See Moyat, Mon. Teint. 1892, **36**, 50. See also H. Silbermann, Faerb. Ztg. 1893, 315; abst. Wag. Jahr. 1893, **39**, 979, 1048.
1. U. S. P. 559392, 562626, 562732, 1896; 680719, 1901. 713999. E. P. 11831, 1891; abst. J. S. C. I. 1892, **11**, 680. E. P. 22736, 1892; 24003, 1893; abst. J. S. C. I. 1894, **13**, 1192. E. P. 24009, 1894; 2595, 10868, 1896; 17759, 1900; abst. J. S. C. I. 1901, **20**, 1109. E. P. 20461, 1900. F. P. 221901, 1892; 224460, 1893; 243677, 1894. D. R. P. 55949, 1889; 58508, 1890; abst. Wag. Jahr. 1891, **37**, 1112. D. R. P. 82555, 1894; 125309, 129420, 1900. Ital. P. 27943, 1890, 32656, 1892. Swiss P. 3740, 1891; 4984. Aust. P. 5195, 8359. Aust.-Hung. P. 9475, 54062, 1891. See also Ber. 1891, **24**, 990. Chem. Tech. Rep. 1891, **30**, I, 87; 1891, **30**, II, 121. Wollen Ztg. 1892, **24**, 707. Mon. Text. Ind. 1892, **7**, 101; Cosmos, 1893, **26**, 288; Centr. Text. Ind. 1894, **25**, 393. Chem. Tech. Rep. 1895, **34**, I, 115; II, 127. U. S. Consular Reports, Dec. 1894, 538; abst. J. S. C. I. 1895, **14**, 83, 405. Zts. ang. Chem. 1906, **19**, 1581. Although Lehner demonstrated his process in London, it was in Switzerland that he built up the business associated with his name. See also Koechlin, Soc. Ind. Mulhouse Sitzungs, 1899, p. viii, 22; abst. J. S. C. I. 1889, **8**, 611.

Vivier,¹ the processes of L. Crespin² and M. Denis³ designed to employ the minimum of solvent, as well as the acetone solvent combination of P. Cazeneuve,⁴ all depended upon nitrocellulose as the cellulose ester. Others⁵ refined the art along the lines of

1. F. P. 195654, 195655, 195656, 1889, 208857, 1890, E. P. 2570, 2571, 1889. U. S. P. 563214, 1890. D. R. P. 52977; abst. *Jahr Chem* 1890, **43**, 2881; *Zts. ang. Chem* 1890, **3**, 721; *Wag. Jahr* 1890, **36**, 1105, Belg. P. 84774, 1889; Span. P. 9204, 1889; It. P. 356, 1889. See also F. Hément, *La Nature*, 1889, I, 238. C. deKirivan, *Cosmos*, 1889, **14**, 171. *Chem. Tech. Rep.* 1890, **29**, II, 54.
2. U. S. P. 820351, 1906, being division of application filed Feb. 4, 1905, Serial No. 244186. E. P. 27565, 1904; abst. *J. S. C. I.* 1905, **24**, 543. F. P. 342077, 1904, abst. *J. S. C. I.* 1904, **23**, 899. *Can. P.* 102920, 102921, 1907. *India P. Appl.* 162, 1905.
3. U. S. P. 834460, E. P. 4534, 1905, abst. *J. S. C. I.* 1905, **24**, 880. F. P. 341173, 1904, abst. *J. S. C. I.* 1904, **23**, 864, 452000, 1913. D. R. P. 165331; *Swiss P.* 33571, Belg. P. 180126, 180127, 1905. Cf. F. Bayer & Co., E. P. 13100, 1910. L. Bergier, F. P. 349134. E. Berl, D. R. P. 190885. Calico Printers' Assoc. and E. Fourneaux, E. P. 15080, 1912. M. Friedländer and P. Tuebben, E. P. 23547, 1909. E. Friedrich, F. P. 369957. E. P. 21144, 1906. P. Magnier and L. Doerflinger, E. P. 4711, 1878. G. Müller, E. P. 19387, 1903, Soc. Anon. la soie nouvelle, F. P. 369973. E. P. 20408, 1906. U. S. P. 850695. J. Swan, D. R. P. 30291. E. P. 3678, 1883.
4. F. P. 346693, abst. *J. S. C. I.* 1905, **24**, 194. First add. 3862, dated Oct. 26, 1904, to F. P. 346693; abst. *J. S. C. I.* 1905, **24**, 331. F. P. 350723, 1905; abst. *J. S. C. I.* 1905, **24**, 799. First addn. 4445, dated Feb. 6, 1905, to F. P. 350723, 1905; abst. *J. S. C. I.* 1905, **24**, 967.
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maximum solvent recovery and uniformity of the physical charac-

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the finished silk was a serious drawback to commercial development. Attempts to reduce the inflammability by the introduction of metallic salts as in the methods of R. Valette,¹ D. Bachrach,² R. Langhans,³ L. Bethisy,⁴ A. Plaissetty,⁵ J. du Vivier,⁶ E. Cadoret,⁷ L. Lehner⁸ and others⁹ did not have the desired effect, so that it was necessary to resort to denitration, which decreased the yield by 30% to 40%.

Artificial Filament Formation. In addition to the nitro-cellulose artificial filaments mentioned in the preceding topic, cuprammonium solutions of cellulose (page 68), cellulose in zinc chloride (page 101), and the cellulose xanthates (page 3062) have and are used in immense quantities for filaments simulating natural silk, from which they all differ in being free (or substantially so) from nitrogen. All the artificial filaments which em-

1. E. P. 144563, 1919. L. Ledue and H. Jacquemin, Belg. P. 255401, 1913. Rhemische Kunstseide-Fabrik, A.-G., D. R. P. 246780, 1911. L. Richard and J. Jacquem. F. P. 348354, 1904. M. Ratignier and H. Pervilhac et Cie, F. P. 393412, 1907; abst. J. S. C. I. 1909, **28**, 89. S. Torii, F. P. 407345, 1909; abst. J. S. C. I. 1910, **29**, 556. A. Samuel, F. P. 348137, 1904; abst. J. S. C. I. 1905, **24**, 438, 454. Vereinigte Kunstseidefabriken A.-G., Belg. P. 254537. Hung. P. Appl. K-5579; abst. Chem. Ztg. 1913, **37**, 537, 785. H. Wyss-Naeff, Zts. ang. Chem. 1899, **20**, 31.
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3. E. P. 2339, 1901; J. S. C. I. 1901, **20**, 741.
4. U. S. P. 571530, 1896. F. P. 217557, D. R. P. 72572, 82857; abst. Mon. Sci. 1892, **40**, 216, 1894, **44**, 55; 1896, **48**, 72. Ber. 1894, **27**, 281-R; 1895, **28**, 918-R. Jahr. Chem. 1895, **41**, 1362. Wag. Jahr. 1895, **41**, 957; Text. Col. 1897, **19**, 317. Ind. Text. 1897, **13**, 239.
5. U. S. P. 625313, 1899. F. P. 275161; E. P. 11927, 1896; D. R. P. May 24, 1898.
6. E. P. 9087, 1900; J. S. C. I. 1901, **20**, 709.
7. F. P. 195654, 195655, 195656, 1889; 208856, 208857, 1890; E. P. 2570, 2571, 1889. D. R. P. 52977; abst. J. S. C. I. 1890, **9**, 286; Mon. Sci. 1905, **62**, 323, 324. Ber. 1891, **24**, 320. Chem. Tech. Rep. 1890, **29**, II, 54; Jahr. Chem. 1890, **43**, 2881. Tech. Chem. Jahr. 1890, **13**, 516; Zts. ang. Chem. 1890, **3**, 721; Industriebl. 1891, **46**, 71. U. S. P. 563214, 1896; Belg. P. 84774, 1889. Span. P. 9204, 1889. Ital. P. 356, 1889. See also Rev. Indust. 1890, 194.
8. E. P. 21485, 1892; J. S. C. I. 1893, **12**, 779; Farb. Ztg. **31**, 144.
9. D. R. P. 55049, 82555, abst. Mon. Sci. 1894, **44**, 29; Ber. 1895, **28**, 880; Chem. Ztg. 1895, **19**, 1791. Jahr. Chem. 1895, **48**, 1362; Wag. Jahr. 1891, **37**, 1112, 1895, **41**, 957. Zts. ang. Chem. 1891, **4**, 434; 1895, **8**, 608.
10. P. Germain, F. P. 360396, 1905; J. S. C. I. 1906, **25**, 636. W. Krug and J. Blomen, J. A. C. S. 1897, **19**, 532. Soc. Anon. de Produits Chimiques de Droogenbosch, E. P. 5076, 1901; Soc. Anon. pour l'Etude Ind. de la Soie Serret, F. P. 369170, 1906. Soc. pour la fabrication en Italie de la soie Artif. par le procede de Chardonnnet, F. P. 367803, 1906. H. Chardonnnet, Ind. Text. 1893, **9**, 175. D. Lancee, D. R. P. 234302, 234303.

played cellulose as a base or initial basic material, when in the finished salable condition, represent some form of modified cellulose.

From the original efforts of G. Audemars¹ and of F. Lotteri² in 1855, who both employed mulberry bark as the initial material for filament formation, to the present time, an almost incredible amount of combined mechanical manipulation and chemical experimentation has been brought to bear upon the subject of reproducing this valuable material without the interposition of the "life" process, and to day, in the face of the over two thousand patented processes which have been evolved covering the details of this general subject, the problem - in comparison to the physical characteristics of the natural filament - is in many essentials, far short of satisfactory solution.³

The commercial elucidation of this problem to the present

1. E. P. 283, 1855

2. E. P. 2636, 1855

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day standard has been rather a combination of pure chemistry and chemical engineering, aided by exact microscopical work, than one, primarily of chemistry alone. The proper delineation of the rise and perfection of this art—for art it surely is—forms the subject matter of Volume Four of this series, only the more important points in connection therewith being briefly touched upon herein.¹

The spinning process on changing the dissolved cellulose into a coagulated workable filament after extrusion through capillary orifices into a coagulating medium, is one of the most important steps in manufacture, details of which are to be found in the processes and devices of J. Achard and C. Gonon,² E. Adolff,³ C. Althouse,⁴ C. Baj,⁵ J. and C. Bedford,⁶ J. P. Bemberg, Akt. Ges.,⁷ E. Berl and M. Isler,⁸ A. Bernstein,⁹ A. Boisson,¹⁰

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- B. Borzykowski,¹ C. Bouillot,² J. Brandenberger,³ C. Buffard,⁴
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 Crepelle-Fontaine,¹³ L. Crespin,¹⁴ J. Criggal,¹⁵ W. Crombie,¹⁶ W.
 Crombie and F. Schubert,¹⁷ E. Crumiere,¹⁸ J. Debourg,¹⁹ H. De-
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and J. Urban,¹ E. Friedrich,² P. Friedrich,³ E. Garnier and P. Vuillaume,⁴ General Artificial Silk Co.,⁵ A. Gerard,⁶ P. Girard,⁷ P. Girard and C. Buffard,⁸ P. Girard and J. Sonnery,⁹ P. and A. Gourdin,¹⁰ C. Grandquist,¹¹ G. Guadagni,¹² E. de Haën Chem. Fabrik "List",¹³ Hamel Aktiengesellschaft,¹⁴ J. Hartogs,¹⁵ P. Hell-

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- berg,¹ A. Herzog,² A. Hill,³ R. Hömberg,⁴ J. Hübner,⁵ J. Inwald,⁶ Akt. G.,⁶ A. and C. Jenner,⁷ H. Kaiser,⁸ S. v. Kapff,⁹ F. Kösewitz,¹⁰ V. Krafft,¹¹ P. Kraus,¹² F. Kreissl and C. Seibert,¹³ F. Küttner,¹⁴ A. Latapie,¹⁵ C. Leclaire,¹⁶ L. Lederer,¹⁷ F. Lehner,¹⁸ A. Leinveber,¹⁹ **36**, 598.
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12. Faser. 1919, **1**, 121; abst. C. A. 1920, **14**, 847.
 13. F. P. 425055, 1911; U. S. P. 1001284, 1911; abst. J. S. C. I. 1911, **30**, 950, 1112.
 14. E. P. 28083, 28103, 28320, 1912; abst. J. S. C. I. 1913, **32**, 748; 1913, **32**, 907; F. P. 450818, 450985, 450906, 1912; abst. J. S. C. I. 1913, **32**, 596; Kunst. 1913, **3**, 177, 196; D. R. P. Ann. K-52056, 1912; abst. Kunst. 1913, **3**, 479; Belg. P. 251073, 251191, 251256, 251829, 1912; abst. Kunst. 1913, **3**, 235; Swiss P. 62313, 1912; Holl. Ann. 1669, 1670; abst. Chem. Ztg. 1913, **37**, 968, 980; Ital. P. 396 250 129620. In this connection see E. P. 27676, 1912; F. P. 450818, 451276, 453569; Aust. P. Ann. 5142, 1912; Ital. P. 397 210 129723; Port. P. 8546; Belg. P. 253139; Hung. Ann. 5268, 5424, 5473, 5476, 1912; abst. Chem. Ztg. 1913, **37**, 44, 254, 302, 419, 528, 681, 1026, 1125, 1265, 1322; J. S. C. I. 1913, **32**, 596.
 15. F. P. 431096, 1911; abst. Kunst. 1912, **2**, 17; J. Soc. Dyers Color. 1911, **27**, 206.
 16. F. P. 350026, 1905, 399727, 1908; 406724, Add. 11840; 414520, 1909, 425953, 431681; abst. Kunst. 1911, **1**, 295.
 17. D. R. P. 240751; abst. C. A. 1912, **6**, 2179; Chem. Zentr. 1911, **82**, 1843; Chem. Ztg. Rep. 1911, **35**, 624; Wag. Jahr. 1911, **57**, II, 421.
 18. U. S. P. 559392, 562626, 562732; E. P. 11831, 1891, 22736, 1892; 24003, 1893, 24009, 1894; 2595, 10868, 1896; F. P. 221901, 224460, 243612, 243677; D. R. P. 55949, 58508, 82555.
 19. F. P. 320529, 1902; abst. J. S. C. I. 1903, **22**, 25. See also F. Kreissl and C. Seibert, U. S. P. 1001284, 1911; F. P. 425055, 1911; abst. J. S. C. I. 1911, **30**, 950, 1112.

- G. Lequeux,¹ R. Linkmeyer,² Akt. Ges. Lointier,³ B. Loewe,⁴ H. Luxberg,⁵ H. Madden and W. Houskeeper,⁶ J. Manquat,⁷ F. Mancelin,⁸ V. Martin,⁹ V. Martin and A. Vennin,¹⁰ Meister, Lucius & Brünig,¹¹ E. Mertz,¹² R. Mewes,¹³ P. Meyer,¹⁴ A. Monod,¹⁵ W. Morton,¹⁶ L. Morane,¹⁷ A. Moriceau,¹⁸ Moss,¹⁹ M. Müller,²⁰ O. Müller and Gebr. Franke,²¹ Gocher Oelmühle Gebr. van den

1 F. P. 415619

2 E. P. 6357, 1905 Belg. P. 183197, 183198, 1905, abst. J. Soc. Dyers Color. 1905, **21**, 331 D. R. P. 249002, abst. Wag. Jahr. 1912, **58**, II, 437.

3 Belg. P. 253805, abst. Kunst. 1913, **3**, 357, Chem. Ztg. 1913, **37**, 472

4 U. S. P. 1151487, 1915, abst. C. A. 1915, **9**, 2818 E. P. 18086, 18087, 1909, 19450, 1911, abst. J. S. C. I. 1910, **29**, 941; Kunst. 1911, **1**, 34 F. P. 403242, 403243, Add. 13215, 13253, 1908, abst. J. S. C. I. 1909, **28**, 1310, 1911, **30**, 415 D. R. P. 234927, 235602, 238160, 252059, abst. C. A. 1912, **6**, 2006, 2176, Kunst. 1911, **1**, 277, 1912, **2**, 399, 475, Wag. Jahr. 1911, **57**, II, 424, Swiss P. 45288, 45289, 1909, 59177, 1911 Aust. Ann. A. 7351, 1910, abst. Kunst. 1912, **2**, 320 Hung. Ann. I. 3079, 1911 Belg. P. 212737, 1908, 238479, 1911

5 E. P. 1407, 1909, abst. J. S. C. I. 1910, **29**, 208, J. Soc. Dyers 1910, **26**, 66

6 E. P. 7331, 1910, abst. J. S. C. I. 1911, **30**, 77

7 E. P. 12710, 1912, abst. Kunst. 1911, **4**, 54 F. P. 440965, 1911 Swiss P. 61380, 1912 Belg. P. 246438, 1912 Holl. P. Ann. 582, abst. Chem. Ztg. 1913, **37**, 684

8 F. P. 469890, 1914; abst. Kunst. 1915, **5**, 22, J. S. C. I. 1915, **34**, 24

9 E. P. 18680, 1913, abst. J. S. C. I. 1914, **33**, 477 Belg. P. 248663, 248664, 1912

10 F. P. 461432, 1913, abst. Kunst. 1914, **4**, 173

11 Belg. P. 180370, 1904 See F. and W. Mitchell, E. P. 29030, 1911

12 F. P. 219538, 364912, 364913, 1906, abst. J. S. C. I. 1906, **25**, 981 Belg. P. 191165, 191166, 191168 Swiss P. 4449, 34741, 34742, 34743.

13 D. R. P. 252841, 276082, abst. C. A. 1913, **7**, 1104, Wag. Jahr. 1912, **58**, II, 252, 841, Kunst. 1913, **3**, 51; 1914, **4**, 318, Kunst. 1912, **2**, 300, 1914, **3**, 139

14 D. R. P. 244098, 1911, abst. C. A. 1912, **6**, 2197, Zts. ang. Chem. 1912, **25**, 735, J. S. C. I. 1912, **31**, 462

15 Belg. P. 236469, 1911

16 U. S. P. 705691, 1902, abst. J. A. C. S. 1903, **25R**, 103.

17 U. S. P. 1069456, 1913, abst. J. S. C. I. 1913, **32**, 865 E. P. 24707, 1910, abst. J. S. C. I. 1911, **30**, 126 F. P. 261726, 1896, 410267, 1909, Add. 12545, 1910, abst. J. S. C. I. 1910, **29**, 810, Kunst. 1911, **1**, 196 D. R. P. 243658, 243569, 1910, 245574, abst. C. A. 1912, **6**, 2326, Wag. Jahr. 1912, **58**, II, 435 Aust. P. 51140, 1910, abst. Kunst. 1912, **2**, 75 Belg. P. 229735, 1910, Swiss P. 54645, 1910.

18 E. P. 377619, 1907 Belg. P. 207912, 1908.

19 Text. Mfr. 1903, **29**, 147.

20 F. P. 422968, 1910, Add. 14248, 1911, abst. Kunst. 1912, **2**, 16; J. Soc. Dyers Color. 1911, **27**, 224.

21 E. P. 3606, 4015, 1907, 4078, 4080, 1911, 2222, 1912, abst. J. S. C. I. 1907, **26**, 1135; 1912, **31**, 328; Kunst. 1912, **2**, 234 F. P. 450696, 1912, abst. J. S. C. I. 1913, **32**, 531 D. R. P. 257237, 1910; abst. C. A. 1913, **7**, 2690; Chem. Ztg. 1913, **37**, 216 Belg. P. 251000, abst. Kunst. 1913, **3**, 235 D. R. G. M. 547071; abst. Chem. Ztg. 1913, **37**, 420

Bosch,¹ R. Pawlikowski,² A. Pellerin,³ Pervilhac & Co.,⁴ H. Ping and F. Schubert,⁵ J. Poizat,⁶ M. Ratignier and H. and G. Pervilhac,⁷ deRedon de Colombier,⁸ W. Reents and F. Eilfeld,⁹ Rheinische Kunstseidenfabrik,¹⁰ J. and H. Röhrens,¹¹ E. Ryon and C. Waite,¹² C. Sandoz-Moritz & Co.,¹³ J. Saint-Rene and J. Tissier,¹⁴ L. Sarason,¹⁵ J. Sauverzac,¹⁶ F. Scheys,¹⁷ A. Sedeyen,¹⁸ Severen,¹⁹ R. Sohlman,²⁰ Soc. Anon. des Planchon,²¹ Soc. Filature Francaise de

1. E. P. 6942, 1906; 3606, 1907; F. P. 366126, 373887; Swiss P. 39711. (Cf. Rheinische Kunstseide Fabrik., Aust. P. 36922.) F. P. 374790, 1907; D. R. P. 188910; Swiss P. 42026, Aust. P. 32553 (Cf. O. Muller, E. P. 4015, 1907.) Swiss P. 39711, 39831, 1907; 42026, Belg. P. 197896, 198000, 1907. D. R. P. 178380, 1905; 186203, 1907. Aust. P. 32553.
2. E. P. 16629, 1910. F. P. 417851, 1910. Aust. P. Anm. A-4915, 1910.
3. E. P. 7562, 1913; F. P. 442022, 1912, D. R. P. 271215, 1913; abst. C. A. 1914, **8**, 2490, J. S. C. I. 1912, **31**, 916; 1913, **32**, 1006. Ital. P. 40679/133197, 1913; abst. Chem. Ztg. 1913, **37**, 1334. E. P. Appl. 21084, 1918; abst. J. S. C. I. 1919, **38**, 31-A. Belg. P. 255192; abst. Chem. Ztg. 1913, **37**, 653.
4. E. P. 13518, 1907; F. P. 384034, D. R. P. 200509, 1907. Swiss P. 40674. Aust. P. 33498, abst. J. S. C. I. 1907, **26**, 1196.
5. E. P. 11635, 1911; abst. C. A. 1913, **7**, 1287; J. S. C. I. 1911, **30**, 1236, 1912, **31**, 1074. J. Soc. Dyers Color. 1912, **28**, 369.
6. F. P. 471323, 1913. See Koelner Accumulatoren Werk, G. Hager, D. R. P. 163233, 1904.
7. E. P. 28538, 1908; 10673, 1911, F. P. 440221, 1911; abst. J. S. C. I. 1909, **28**, 492, 543, 1912, **31**, 681.
8. Belg. P. 229747, 1910.
9. D. R. P. 221572, 1909, abst. Chem. Ztg. Rep. 1910, **34**, 299.
10. D. R. P. 218586, 1910, 246780, 1911; abst. C. A. 1912, **6**, 2541; Zts. ang. Chem. 1912, **25**, 1549; Wag. Jahr. 1912, **58**, II, 439; Kunst. 1912, **2**, 294. D. R. P. Anm. R-32549, 1911. Aust. P. Anm. 9791, 1909; Aust. P. 54785, 1912, abst. Chem. Ztg. 1912, **36**, 489, 975. D. R. G. M. 509643, 1911; abst. Chem. Ztg. 1912, **36**, 661.
11. F. P. 364269, 1906; abst. J. S. C. I. 1906, **25**, 1041. Aust. P. 27038. Belg. P. 190844, 1906.
12. U. S. P. 732784, 1903. Apparatus for producing artificial silk; abst. J. S. C. I. 1903, **22**, 948.
13. Swiss P. 58180, 1911. Spinneret for the manufacture of artificial silk.
14. E. P. 27303, 1910. Manufacture of yarn from kapok.
15. Belg. P. 249325; abst. Kunst. 1913, **3**, 178. E. P. 21586, 1912; D. R. P. 258810, 200812, abst. C. A. 1913, **7**, 3237; Wag. Jahr. 1913, **59**, II, 448. Russ. P. 55215, 1912, Aust. P. Anm. 4851, 1912; Swiss P. 59641; Hung. P. Anm. S-6439; abst. Chem. Ztg. 1913, **37**, 528, 586, 865, 1038.
16. F. P. 349620, 1904; 385957, 1907, 415060, 420085, 1909.
17. Belg. P. 187284, 1905. Apparatus for distributing solution in the manufacture of artificial silk.
18. Belg. P. 187054, 1905. Dyeing artificial silk.
19. F. P. 368158, 1906.
20. E. P. 9431, 1897. A. Nobel, by R. Sohlman, executor.
21. U. S. P. 888260, 1908; 1093146, 1914; abst. C. A. 1914, **8**, 2065. E. P. 13360, 1913; abst. J. S. C. I. 1914, **33**, 196; Kunst. 1914, **4**, 173. F. P. 399218; 474728, 1913; D. R. P. 219128; abst. Wag. Jahr. 1910, **56**, II, 436. Cf. A. Lumiere, D. R. P. 200265, E. P. 89, 89-A, 1907.

Chanvre et D'Etoupes,¹ Societe Desmarais, Morane and M. Denis,² Societe Francaise de la Viscose,³ Fab. de soie art d'Obourg,⁴ Soc. Boullier et Lafais,⁵ Societe General de Soie Art par le Procédé Viscose,⁶ Societe anon. Fabrique de Soie Artificielle de Tubize,⁷ La Societe de la Soie Artificielle Linkmeyer,⁸ Societe La Setoid,⁹ Societe Anon. LaSoie de Basecles,¹⁰ Soc. anon. des. Plaques et Papiers Photographiques A. Lumiere et ses Fils,¹¹ H. Specht,¹² C. Stearn and C. Topham,¹³ J. Stoerk, G. Dubois and A. de Baudry d'Asson,¹⁴ R. Strehlenert,¹⁵ K. Suvern,¹⁶ E. Thiele,¹⁷ P. Follet and

1. F. P. 370908, 1906.
2. E. P. 6783, 1905, F. P. 342655, 1904, D. R. P. 197167, 1907, Swiss P. 33335; abst. J. S. C. I. 1904, **23**, 933.
3. D. R. P. 160244, 163467, abst. Wag. Jahr. 1905, **51**, II, 386. D. R. P. 164321, 168171, 192406; abst. Zts. ang. Chem. 1908, **21**, 403, 1103; Wag. Jahr. 1908, **54**, II, 355. E. P. 17152, 5730, 1904. F. P. 340812, 345274, 345320, 361877, 377424. Belg. P. 178768, 1904. Swiss P. 30322, 38455. Aust. P. 19037, 34101. Cf. A. Delubac, U. S. P. 923777. I. Naudin, U. S. P. 733412.
4. D. R. P. 287968, 1913; abst. C. A. 1916, **10**, 2155. Belg. P. 180126, 180127, 188233, 263133, abst. Kunst. 1914, **4**, 319.
5. E. P. 15015, 1908, F. P. 392442, 1908; D. R. P. 210867, 1908, abst. J. S. C. I. 1908, **27**, 1201, 1909, **28**, 202.
6. Aust. P. 25175. Cf. C. Topham, E. P. 5766, 1905.
7. E. P. 2906, 3025, 1906, 11729, 1610, abst. J. S. C. I. 1906, **25**, 1144; 1907, **26**, 196. F. P. 370717, 1906; abst. J. S. C. I. 1907, **26**, 253. D. R. P. 234672; abst. Zts. ang. Chem. 1911, **24**, 1151, Chem. Zentr. 1911, **82**, I, 1771; Wag. Jahr. 1911, **53**, II, 426. Belg. P. 187728, 1905, 189828, 1906. Aust. P. 47780.
8. E. P. 14655, 1907, abst. J. S. C. I. 1908, **27**, 278. Belg. P. 200970, 1907.
9. F. P. 478315, 1915, abst. J. S. C. I. 1916, **35**, 1152.
10. D. R. P. 245100, abst. Wag. Jahr. 1912, **58**, II, 436. D. R. P. 245440; abst. Wag. Jahr. 1912, **58**, II, 438, C. A. 1912, **6**, 2198, Zts. ang. Chem. 1912, **25**, 978; Kunst. 1912, **2**, 232. D. R. P. 245574, 1911, abst. Kunst. 1912, **2**, 234; Wag. Jahr. 1912, **58**, II, 436.
11. F. P. 350188, 1904; 361323, 361324, 361329, 361960, 1905, abst. Mon. Sci. 1908, **68**, 28. F. P. 382718, 1907. D. R. P. 173012, 200265; abst. Wag. Jahr. 1906, **52**, I, 389. E. P. 89, and 89 A, 1907. Swiss P. 38910. Cf. V. Planchon, U. S. P. 888260, 1908.
12. U. S. P. 1310509, 1919, abst. C. A. 1919, **13**, 2458.
13. E. P. 16605, 1903, abst. J. S. C. I. 1904, **23**, 834. C. Stearn, U. S. P. 725016, 1903. E. P. 2529, 1902. Belg. P. 138452, 1898. D. R. P. Anm. St-17549, 1912; abst. Kunst. 1913, **3**, 120.
14. U. S. P. 713360, 1902; abst. J. S. C. I. 1903, **22**, 24.
15. U. S. P. 702163, 716138, 1902; abst. J. S. C. I. 1902, **21**, 969; 1903, **22**, 92. E. P. 3832, 1897; 58, 1899; 283364, 1902; abst. J. S. C. I. 1897, **16**, 533. D. R. P. 143763, 148038; abst. Wag. Jahr. 1903, **49**, II, 415; 1904, **50**, II, 393. Belg. P. 126262, 1897, 138726, 1898. Swiss P. 13695, 1897; 17950. Can. P. 63387, 1899. Mon. Text. Ind. 1897, **12**, 752. R. Strehlenert and C. Grandquist, D. R. P. 90208, 101844, 102573; abst. Wag. Jahr. 1903, **49**, II, 417.
16. Kunst. 1916, **6**, 4, 19; abst. C. A. 1916, **10**, 971.
17. U. S. P. 710819, 1902; 750502, 1904; 838758, 1906; abst. J. S. C. I.

G. Ditzler,¹ C. Topham,² W. Traube,³ L. Vangenechten,⁴ Vereinigte Kunstseidefabriken Akt. Ges.,⁵ Ver. Glanzstoff Fabriken,⁶ J. Vermeesch,⁷ P. Vilan and La Soie Artificielle de Nord,⁸ P. Vindrier,⁹ H. Vittenet,¹⁰ J. du Vivier,¹¹ M. Waddell,¹² C. Waibel,¹³ M. Weertz,¹⁴ E. Tetley and J. Clayton,¹⁵ W. Werner,¹⁶ J. Wilkinson and Bradford Dyers Assoc., Ltd.,¹⁷ L. Wilson,¹⁸ C. Woegerer,¹⁹ H.

1902, **21**, 1393, 1907, **26**, 197. E. P. 7660, 1894; 8083, 1902; 16588, 1903; 16078, 1906, abst. J. S. C. I. 1906, **25**, 924. F. P. 320446, 334507, 1903; 367080, 1906, abst. J. S. C. I. 1904, **23**, 59, 1906, **25**, 1144. D. R. P. 133427, 118889, 154507, 157157, 178942, 225161; abst. Wag. Jahr. 1902, **48**, II, 469; 1904, **50**, II, 390, 1906, **52**, II, 391, 392. Jahr. Chem. 1905-08, II, 987; Zts. ang. Chem. 1907, **20**, 369; Chem. Tech. Rep. 1907, **31**, 22; Chem. Centr. 1906, **77**, II, 990. Swiss P. 29680, 35436. Aust. P. 18082, 21119, 31778. Belg. P. 171980, 1903, 192911, 1906.

1. Swiss P. 44075, 1908.

2. U. S. P. 702382, 1902. E. P. 23157, 23158, 1900, 10029, 1901; abst. J. S. C. I. 1901, **20**, 1207; 1902, **21**, 870. D. R. P. 125947, 127046, 138507, abst. Wag. Jahr. 1902, **48**, II, 469. Belg. P. 157100, 1901. Aust. P. 9548, 12388. Swiss P. 24301.

3. D. R. P. 245575, abst. J. S. C. I. 1912, **31**, 532. E. P. 356, 1912. Swiss P. 58882, abst. Chem. Ztg. 1913, **37**, 419.

4. Belg. P. 212126, 1908, abst. Mon. Sci. 1910, **73**, 291.

5. Belg. P. 242387, 1912. F. P. 454011, 1913; abst. J. S. C. I. 1913, **32**, 865. E. P. 2902, 1913; abst. C. A. 1914, **8**, 2620. Ital. P. 401/176/131544, 1913, Hung. Ann. G. 3227, 1910, abst. Chem. Ztg. 1912, **36**, 162; 1913, **37**, 1265.

6. Belg. P. 231227, 1910. Hung. Ann. 3206, 1910, Swiss P. 53777, 53936, 1910, abst. Chem. Ztg. 1912, **36**, 88, 327, 350.

7. Belg. P. 183782, 1905. Addn. thereto Belg. P. 184228, 1905.

8. F. P. 465322, 1913. E. P. 4513, 1914.

9. F. P. 442015, 1911, abst. J. S. C. I. 1912, **31**, 916, Kunst. 1912, **2**, 371.

10. E. P. 1686, 1905, 14087, 1906; F. P. 350383, 1904, abst. J. S. C. I. 1905, **24**, 921, 1906, **25**, 177. Belg. P. 192853, 1906. U. S. P. 828155. F. P. 361568, Addn. 5795, D. R. P. 194825. Aust. P. 32783.

11. U. S. P. 563214, 1896. E. P. 2570, 2571, 1889. F. P. 195654, 195655, 195656, 1889, 208856, 208857, 1890. D. R. P. 52977.

12. U. S. P. 816879, 849822, 849870, 867623, 1907; abst. J. S. C. I. 1907, **26**, 922. E. P. 7690, 1907, abst. J. S. C. I., 1908, **27**, 558. F. P. 375633, 1907, abst. J. S. C. I. 1907, **26**, 922. D. R. P. 204215, abst. Zts. ang. Chem. 1908, **21**, 2557, Chem. Ztg. Rep. 1909, **33**, 91. Cf. E. P. 5881, 1907.

13. U. S. P. 483590, 1892, abst. J. A. C. S. 1892, **14**, 318.

14. E. P. 10211, 1910, abst. J. S. C. I. 1911, **30**, 415; Kunst. 1911, **1**, 197.

15. E. P. 17876, 1907, 19157, 19158, 1908, abst. J. S. C. I. 1909, **28**, 880. F. P. 406344, 1909. J. Clayton, E. P. 139104, 1919, abst. J. S. C. I. 1920, **39**, 293-A.

16. U. S. P. 697580, 1902, abst. J. S. C. I. 1902, **21**, 614. E. P. 1850, 1901; abst. J. S. C. I. 1902, **21**, 771.

17. E. P. 10186, 1910, F. P. 427381, 1911, abst. J. S. C. I. 1911, **30**, 679, Kunst. 1911, **1**, 275.

18. L. Wilson, Swiss P. 43016, 1908. Cf. Societe Francaise de la Viscose, U. S. P. 970589, 1910; F. P. 394586, 1908.

19. U. S. P. 988424, 1911, abst. C. A. 1911, **5**, 2180.

Woltreck,¹ C. Kellner,² E. Legrand,³ G. Pun,⁴ C. Sammet and J. Merrill,⁵ C. Sanlaville,⁶ H. Silbermann,⁷ C. Stulemeyer,⁸ D. Rosenblum, L. Blech and E. Tyborowski,⁹ M. Rotten,¹⁰ V. Valles,¹¹ Verein für Chemische Industrie in Mainz,¹² and Zellstoff Verwertungs.¹³

After filament formation, the "raw silk" is unsuitable for commercial uses until after subjection to a series of processes designed to soften, strengthen, color and otherwise more nearly approach the natural product in appearance and properties. The softness is enhanced and the elasticity augmented by treatments as proposed by P. Girard,¹⁴ J. Friedel,¹⁵ L. Lilienfeld,¹⁶ E. Calliat,¹⁷ Furst Guido Donnersmarcksche Kunst-seiden und Acetatwerke¹⁸ and C. Jacober and A. Rabourdin.¹⁹

The tenacity may be increased by subjecting the filaments to the manipulations devised by R. Strehlenert and Westergren,²⁰ J. Gebauer,²¹ S. Pentacost²² and O. Schlesinger,²³ of especial im-

1. E. P. 3898, 1898, abst. J. S. C. I. 1898, **17**, 205, 520, 574.
2. E. P. 5420, 1890, 24136, 1902, F. P. 327176, 1902, abst. J. S. C. I. 1903, **22**, 905, 1290.
3. F. P. 303530, 1900, Hung. P. Ann. L. 3329, L. 3420, 1913, abst. Chem. Ztg. 1913, **37**, 653, 1442.
4. D. R. P. 103900, abst. Wag. Jahr. 1899, **45**, 1157.
5. U. S. P. 1016178, 1911, abst. Chem. Ztg. 1912, **36**, 263.
6. E. P. 21889, 1912, F. P. 435989, abst. C. A. 1914, **8**, 996, J. S. C. I. 1912, **31**, 381, 1913, **32**, 531.
7. Farb. Ztg. **8**, 68, abst. Chem. Centr. 1897, **68**, I, 832.
8. E. P. 142038, 1919, abst. J. S. C. I. 1920, **39**, 388 A.
9. F. P. 438130, E. P. 5552, 1911, Ital. P. 35 123 115727, 1911, abst. J. S. C. I. 1912, **31**, 329, Chem. Ztg. 1912, **36**, 500, Mon. Sci. 1912, **76**, 570, 1913, **79**, 181.
10. D. R. P. 98201, 1897, abst. Chem. Centr. 1898, **69**, II, 742.
11. Belg. P. 257538, abst. Chem. Ztg. 1913, **37**, 1038.
12. D. R. P. 290131, 1916, abst. Chem. Zentr. 1916, **87**, I, 352, J. S. C. I. 1916, **35**, 533.
13. D. R. P. 323431, 1919, abst. Chem. Ztg. 1920, **44**, 393.
14. F. P. 451913, 1912. In this connection refer to E. P. 143253, 144563, 145035, 145610, 145611, 145627, 146082, 147378, 147416, 147417.
15. F. P. 463160, 1913, abst. C. A. 1914, **8**, 3373.
16. F. P. 438448, 1911, 459972, 1913, abst. J. S. C. I. 1912, **31**, 584, E. P. 26928, 1910, abst. J. S. C. I. 1912, **31**, 122. D. R. P. Ann. L. 34636, 1911; abst. Kunst. 1913, **3**, 60. Aust. P. 47237, 47238, 47239, 1910. L. Lilienfeld and G. Winterbottom, U. S. P. 888516, 1908, E. P. 592, 1907, abst. J. S. C. I. 1908, **27**, 683.
17. F. P. 426217, 1910, abst. Mon. Sci. 1913, **79**, 23.
18. E. P. 23683, 1906, F. P. 370741, 1906, abst. J. S. C. I. 1907, **26**, 253.
19. E. P. 16785, 1894. C. Marx, U. S. P. 1120730, 1914, abst. C. A. 1915, **9**, 382.
20. Chem. Ztg. 1901, **25**, 1100; abst. J. S. C. I. 1902, **21**, 113.
21. F. P. 403264, 1909, Addn. 11164, abst. Mon. Sci. 1910, **73**, 176, 450.
22. J. S. C. I. 1916, **35**, 586; abst. C. A. 1916, **10**, 2304.
23. Pap. Ztg. 1895, 1578; abst. Wag. Jahr. 1895, **41**, 960.

portance to the filaments while in the damp or wet state, in which the tenacity is at the minimum.

A property of prime importance aimed at in all artificial filaments is the production of a thread of high luster. Many ideas have been advanced looking toward the accomplishment of this, and are detailed in the manipulations disclosed by C. Gunther,¹ J. Hubner,² Heberlein & Co.,³ W. Dreaper,⁴ A. Vautier,⁵ R. Hoernberg,⁶ A. Palmer,⁷ E. Schramm,⁸ E. Pohl,⁹ H. Jacob,¹⁰ L. Schreiner,¹¹ C. Stuart,¹² A. Dubois,¹³ F. Bernhardt,¹⁴ Wickels Metallpapierwerke,¹⁵ E. Pohl,¹⁶ J. Sauverzac,¹⁷ Vereinigte Kunstseidefabriken A. G.,¹⁸ E. Calliat,¹⁹ Societe des Cellulose Planchon,²⁰ A. Palmer,²¹ H. Dutschke,²² A. Herzog,²³ A. Buntrock,²⁴ L. Hermsdorf and B. Teufer,²⁵ L. Hesse,²⁶ A. d'Asson and J. Stoerk.²⁷

In recent years a number of methods have been developed

1. D. R. P. 237666, 1910, abst. Chem. Ztg. 1911, **35**, 555; C. A. 1912, **6**, 2149.
2. E. P. 19166, 1910, abst. Chem. Ztg. Rep. 1912, **36**, 13. See La Nature, 1905, II, 1900.
3. E. P. 3861, 1901. F. P. 481561, 1916; abst. C. A. 1917, **11**, 3119. Cf. D. R. P. 290444, 292213, 1914; abst. C. A. 1917, **11**, 1311.
4. E. P. 11959, 1908, abst. J. S. C. I. 1909, **28**, 791.
5. E. P. 2091, 1862. F. Evers, E. P. 25145, 1909, abst. J. Soc. Dyers Col 1911, **27**, 12.
6. Belg. P. 168556, 1903.
7. F. P. 408303, 1909, abst. J. Soc. Dyers Col 1910, **26**, 96.
8. E. P. 6206, 1906; abst. J. Soc. Dyers Col 1907, **23**, 27.
9. U. S. P. 911906, 911907, 920775, 1909, 947027, 1910, abst. J. S. C. I. 1909, **28**, 241, 598, C. A. 1910, **4**, 675.
10. E. P. 19095, 1893, abst. J. S. C. I. 1893, **12**, 885; 1894, **13**, 860, 944.
11. U. S. P. 1020117, 1912, abst. C. A. 1912, **6**, 1369.
12. U. S. P. 709524, 1902, abst. J. S. C. I. 1902, **21**, 1276.
13. U. S. P. 723147, 1903, abst. J. A. C. S. 1903, **25R**, 492.
14. E. P. 20728, 1909, abst. C. A. 1910, **4**, 1387.
15. E. P. 13485, 1904, abst. J. Soc. Dyers Col 1905, **22**, 48.
16. U. S. P. 808402, 1905, abst. J. Soc. Dyers Col 1906, **22**, 112.
17. F. P. 349620, 1904, abst. J. S. C. I. 1905, **24**, 727.
18. Belg. P. 190631, 1906. B. Loewe, D. R. P. 234927, 1911; 252059; abst. Chem. Ztg. 1912, **36**, 1197.
19. F. P. 426217, 1910, abst. Mon. Sci. 1913, **79**, 23.
20. D. R. P. Anm. S-31578, 1910. See P. Girard, Belg. P. 247209, 1912; abst. Chem. Ztg. 1912, **36**, 1209.
21. F. P. 408303, 1909, abst. J. S. C. I. 1910, **29**, 624; J. Soc. Dyers. 1910, **26**, 96. U. S. P. 786144, 1905, abst. J. S. C. I. 1905, **24**, 492.
22. D. R. P. 285023, 288184, 1913; abst. Kunst. 1915, **5**, 273. F. P. 467670, 1914; abst. J. S. C. I. 1914, **33**, 860.
23. Kunst. 1916, **6**, 153, abst. C. A. 1917, **10**, 1308. Anon. Zts. Spiritusind, 1919, **42**, 359; abst. C. A. 1920, **14**, 2274.
24. Zts. ang. Chem. 1898, **11**, 986; abst. Wag. Jahr. 1898, **44**, 1008. Cf. E. Heberlein, F. P. 257045.
25. F. P. 463073, 1913; abst. C. A. 1914, **8**, 3373; J. S. C. I. 1914, **33**, 248.
26. U. S. P. 1341745, 1920, abst. C. A. 1920, **14**, 2263.
27. U. S. P. 713360, 1902, abst. J. S. C. I. 1903, **22**, 24.

for the strengthening or "sthenosage" of filaments in order to increase their durability—the salient point in which animal (natural) silk is superior to all forms of artificial cellulosic filaments. An indication of the trend of development in this direction is exemplified by the inventions of F. Beltzer,¹ A. Bang and C. Clolus,² P. Benedek,³ Bardy,⁴ E. de Haën,⁵ K. Kishi,⁶ P. Joliot,⁷ A. Nodon,⁸ X. Eschaliér,⁹ T. Eck,¹⁰ J. Eck & Sohne,¹¹ J. Friedel,¹² E. Elsässer,¹³ J. Gebauer,¹⁴ J. Röhrens,¹⁵ C. Shrager and R. Lance,¹⁶ Societe Anonyme pour l'Étude Industrielle de la Soie Serret,¹⁷ R. Strehlen-

1. Mon. Sci. 1907, **66**, 88, 237, 1911, **74**, 633, abst. J. S. C. I. 1911, **30**, 1206. Kunst. 1912, **2**, 412, abst. C. A. 1912, **6**, 3185, 1913, **7**, 551. Eighth Int. Cong. Appl. Chem. 1912, IV, **7**, 7, abst. J. S. C. I. 1912, **31**, 808; C. A. 1912, **6**, 3185. Ind. Chim. **11**, 101. Text. Colorist. 1907, **29**, 296.

2. E. P. 1811, 1881. See H. F. Papeterie, 1920, **42**, 203; abst. C. A. 1920, **14**, 1754.

3. Belg. P. 183106, 1905. W. Brächter, E. P. 25691, 1913; abst. Chem. Ztg. 1913, **37**, 1539.

4. F. P. 313464, 1901, abst. Mon. Sci. 1903, **59**, 57; Chem. Zts. 1902, **2**, 540.

5. F. P. 140907, 1912, abst. Text. Colorist. 1913, 10. D. R. P. 251244, 1911, Ital. P. 375 43 121522, 1911, abst. Chem. Ztg. 1912, **36**, 1000, 1316. J. Hermans and E. de Haën, U. S. P. 1034235, 1912; abst. Chem. Ztg. 1912, **36**, 1156.

6. U. S. P. 1231172, 1917, abst. C. A. 1917, **11**, 2411.

7. F. P. 469416, 1913, abst. J. S. C. I. 1915, **34**, 24. D. R. P. 322047, 1914, abst. Chem. Ztg. 1920, **44**, 342.

8. E. P. 6668, 1913. In connection with the preparation of cellulose see A. Nodon, F. P. 453111; Ital. P. 402 21 131808, 1913, Russ. P. 50477, 1913, abst. Chem. Ztg. 1913, **37**, 567, 1261, 1365.

9. U. S. P. 965852, 1911. E. P. 25647, 1906; abst. J. S. C. I. 1907, **26**, 1297. J. Soc. Dyers Col. 1908, **24**, 119. F. P. 374724, 1906, Add. 8122, 9904, 10760, abst. J. S. C. I. 1909, **28**, 362, D. R. P. 197965, 1906, abst. Wag. Jahr. 1908, **54**, II, 359, Chem. Ztg. Rep. 1908, **32**, 292, Chem. Ind. 1908, **31**, 287. Aust. P. 40076, 40080. Belg. P. 195864, 1906. Can. P. 104856, 1907. Rev. Mat. Color. **12**, 249, abst. Wag. Jahr. 1909, **55**, II, 400.

10. D. R. P. 236297, 1909, abst. C. A. 1912, **6**, 1230, Zts. ang. Chem. 1911, **24**, 1499, Chem. Zentr. 1911, **82**, II, 326, Wag. Jahr. 1911, **57**, II, 418; Kunst. 1911, **1**, 294. D. R. P. Ann. E-17104; abst. Chem. Ztg. 1913, **37**, 326. Russ. P. 55084, 1912, abst. Chem. Ztg. 1913, **37**, 865.

11. D. R. P. 232568, 1910, abst. C. A. 1912, **6**, 1853; Zts. ang. Chem. 1911, **24**, 767.

12. E. P. 21826, 1913; F. P. 463160, 1913; abst. J. S. C. I. 1914, **33**, 417; C. A. 1914, **8**, 3373.

13. U. S. P. 957460, 1910; E. P. 8711, 1908; abst. J. S. C. I. 1908, **27**, 977.

14. E. P. 30510, 1909; abst. J. S. C. I. 1911, **30**, 126; F. P. 403264, 1909; Addn. 11164; abst. J. S. C. I. 1910, **29**, 208. D. R. P. 232605; abst. C. A. 1911, **5**, 2738; Zts. ang. Chem. 1911, **24**, 800; Chem. Zentr. 1911, **82**, I, 1095; Wag. Jahr. 1911, **57**, II, 424; Kunst. 1911, **1**, 136. D. R. P. 235220, 1908, abst. C. A. 1911, **5**, 3169; Zts. ang. Chem. 1911, **24**, 1341; Chem. Zentr. 1911, **82**, II, 119. Belg. P. 216447, 1909.

15. F. P. 364269, 1906; abst. Mon. Sci. 1907, **67**, 600.

16. E. P. 8283, 1913; abst. J. S. C. I. 1913, **32**, 1105. F. P. 453652; abst. Chem. Ztg. 1913, **37**, 568. Belg. P. 255026, 1913.

17. F. P. 354336, 1905; abst. Mon. Sci. 1906, **65**, 167.

ert,¹ Verein Kunstseidefabrik Frankfurt,² W. Morton,³ J. Saint-Germain,⁴ J. Wilkinson,⁵ Müller,⁶ and E. Bayne.⁷

After filament formation, where the product is to be used in the undyed state, it is usually subjected to a careful and non-drastring bleach, employing for this purpose, the processes as perfected by J. Vermeersch,⁸ E. Friedrich,⁹ M. Schneider,¹⁰ F. Erban,¹¹ A. Dulitz,¹² Palmetto,¹³ Badische Aniline & Soda Fabrik,¹⁴ F. Bayer & Co.,¹⁵ J. Bemberger,¹⁶ Chem. Fabrik Griesheim Elektron,¹⁷ Much difficulty has been experienced in the uniform dyeing of artificial filaments, due possibly to the fact that the dried filament represents celluloses in various stages of dehydration, depolymerization and degradation. H. de Chardonnet,¹⁸ V. Clement,¹⁹ Coppetti,²⁰ S. Culp,²¹ E. Dierichs,²² Fürst Guido Donnersmarcksche

1 E. P. 22540, 1896; abst. J. S. C. I. 1896, **15**, 764; 1897, **16**, 711, 728, 907. D. R. P. Anm. St-17575; Swed. P. 34941, 1911; Hung. Anm. S-6394, abst. Chem. Ztg. 1913, **37**, 644, 942, 1150.

2 Text. Rec. 1903, **26**, 128, abst. Text. Mfr. 1903, **29**, 299.

3 U. S. P. 705691, 1902, abst. J. S. C. I. 1902, **21**, 1074.

4 E. P. 11611, 1908; abst. C. A. 1909, **3**, 1467.

5 U. S. P. 1021712, 1912. Cf. H. Frayas and A. Jaboin, E. P. 14759, 14760, 1909.

6 E. P. App. 24737, 1918; abst. J. S. C. I. 1919, **38**, 800-A. C. Muller, E. P. 10430, 1912. O. Muller, Belg. P. 251128; abst. Chem. Ztg. 1913, **37**, 472. E. P. 451406; abst. Chem. Ztg. 1913, **37**, 326. M. Muller, D. R. P. 187947, Aust. P. 33678, P. P. 365776, Swiss P. 42306, E. P. 10094, 1906, U. S. P. 836452, 1906. C. Muller and D. Wolf, D. R. P. Anm. M-46026, 1911; abst. Kunst. 1912, **2**, 420.

7 U. S. P. 920651, 1909; abst. J. S. C. I. 1909, **28**, 970.

8 Belg. P. 185731, 1905, Add. to Belg. P. 183782, 1905. See also L. Monty, Belg. P. 253706, 1913.

9 E. P. 12842, 1906; abst. J. S. C. I. 1907, **26**, 196.

10 Leip. Fabrztg. 1908, 171; abst. Wag. Jahr. 1908, **54**, II, 171.

11 Kunst. 1911, **1**, 167; abst. Wag. Jahr. 1911, **57**, II, 413.

12 Chem. Ztg. 1911, **35**, 189; abst. Wag. Jahr. 1911, **57**, II, 422.

13 Text. World J., 1917, **52**, No. 17, 29; abst. C. A. 1917, **11**, 1550.

14 E. P. 30505, 1909, 27038, 1910, abst. J. S. C. I. 1911, **30**, 127, 1053, 1912, **31**, 1533.

15 Wag. Jahr. 1905, **51**, II, 467. Text. Colorist, 1912, **34**, 228.

16 D. R. P. 165218, 220051; abst. Wag. Jahr. 1905, **51**, II, 433, Chem. Ztg. 1912, **36**, 406, 1913, **37**, 1489. E. P. 390178, 1908. Aust. P. 45320. E. P. 15448, 15449, 1908. Swiss P. 44507, 44963.

17 E. P. 17272, 1914, F. P. 476852, 1914; abst. J. S. C. I. 1915, **34**, 957; 1916, **35**, 357.

18 U. S. P. 410404, 1889. E. P. 5270, 1888, abst. J. S. C. I. 1889, **8**, 474.

19 Farb. Ztg. 1909, **20**, 1, abst. J. S. C. I. 1909, **28**, 136. J. Soc. Dyers Col. 1909, **25**, 247.

20 Ann. Chim. analyt. 1909, **14**, 47, abst. J. S. C. I. 1909, **28**, 305; C. A. 1909, **3**, 1464.

21 Farb. Ztg. 1910, **21**, 141. D. R. P. 274044, 1912, abst. C. A. 1914, **8**, 2955; Wag. Jahr. 1914, **60**, II, 379. See G. Beck, Kunst. 1911, **1**, 280.

22 D. R. P. 211956, 1907, abst. C. A. 1909, **3**, 2756, J. S. C. I. 1909,

- Kunst. und Acetate Werke,¹ E. Esser & Co.,² E. Erban,³ W. Frank,⁴ A. Dulitz,⁵ F. Ganswindt,⁶ P. Germain,⁷ O. Hampel,⁸ E. Heberlem,⁹ E. Herzog,¹⁰ J. Hubner,¹¹ E. Jentsch,¹² H. Koechlin,¹³ F. Kunert,¹⁴ R. Loewenthal,¹⁵ O. Merz,¹⁶ E. Mertz,¹⁷ W. Minajeff,¹⁸ Farbwerke Mulheim vorm. A. Leonhardt & Co.,¹⁹ Meister, Lucius & Bruning,²⁰ W. Mueller,²¹ A. Nakajima,²² M. Saget,²³ E. Springmuhl,²⁴ W. Schaposchnikoff,²⁵ C. Schuler,²⁶ A. Seydel,²⁷ A. Sansome,²⁸ K. 28, 936, Zts. ang. Chem. 1909, **22**, 1698, Chem. Zentr. 1909, **80**, II, 663, Chem. Tech. Rep. 1909, **33**, 460, Wag. Jahr. 1909, **55**, 451.
1. D. R. P. 219848, abstr. Wag. Jahr. 1910, **56**, II, 428, J. S. C. I. 1910, **29**, 559, Chem. Zentr. 1910, **81**, I, 1080, Chem. Ztg. Rep. 1910, **34**, 168, Chem. Ind. 1910, **33**, 238, Chem. Zts. 1910, **9**, 1963. See also D. R. P. 197965.
 2. D. R. P. 219074, abstr. Chem. Ztg. Rep. 1910, **34**, 230, Wag. Jahr. 1910, **56**, II, 480, Lehm. Farber. Ztg. 1910, 133.
 3. Kunst. 1911, **1**, 167, abstr. Chem. Ztg. 1912, **36**, 196, Sci. Text. Colorist, 1909, **31**, 176.
 4. Zts. Farben Ind. 1912, **11**, I, abstr. C. A. 1913, **7**, 1293, Wag. Jahr. 1912, **58**, II, 532, J. Soc. Dyers Col. 1912, **28**, 300, J. S. C. I. 1912, **31**, 429.
 5. Chem. Ztg. 1911, **35**, 189, abstr. C. A. 1912, **6**, 156.
 6. "Das Färben der Seide, Wollseide, Halbwolle und Kunstseide." See C. A. 1911, **8**, 3632, J. S. C. I. 1911, **33**, 811.
 7. F. P. 355016, 360395, 360396, 418928, 1911, abstr. J. S. C. I. 1913, **32**, 423.
 8. Kunst. 1913, **3**, 264, abstr. C. A. 1913, **7**, 3232.
 9. E. P. 13198, 1896, abstr. J. S. C. I. 1896, **15**, 571, 650, 1898, **17**, 660.
 10. Lehm. Farb. Ztg. 1891, **6**, 19, abstr. J. S. C. I. 1895, **14**, 267, Wag. Jahr. 1894, **40**, 980.
 11. E. P. 19166, 1910, abstr. J. S. C. I. 1911, **30**, 1112, J. C. S. 1907, **91**, 1057, abstr. J. Soc. Dyers Col. 1907, **23**, 220.
 12. Farben Ztg. 1908, 36, abstr. Wag. Jahr. 1908, **54**, II, 455.
 13. J. S. C. I. 1889, **8**, 539, 611, D. R. P. 38368, abstr. Wag. Jahr. 1887, **33**, II, 1139, J. S. C. I. 1889, **8**, 611, 1900, **19**, 819.
 14. U. S. P. 1169267, 1916, abstr. C. A. 1916, **10**, 972.
 15. Kunst. 1911, **1**, 205. See Farber. Ztg. 1908, 36.
 16. Kunst. 1913, **3**, 41, abstr. C. A. 1913, **7**, 1293. See Kunst. 1913, **3**, 334.
 17. F. P. 364913, abstr. J. Soc. Dyers Col. 1907, **23**, 45.
 18. Zts. Farben Ind. 1908, **7**, 236, abstr. J. S. C. I. 1908, **27**, 851.
 19. D. R. P. 212651, 1908, abstr. Zts. ang. Chem. 1909, **22**, 2107, Chem. Zentr. 1909, **80**, II, 944, Chem. Ztg. Rep. 1909, **33**, 527, Chem. Ind. 1909, **32**, 594, Wag. Jahr. 1909, **55**, II, 462, Chem. Zts. 1910, **9**, 1686.
 20. D. R. P. 285323, 1914, abstr. J. S. C. I. 1915, **34**, 1138, Chem. Zentr. 1915, **86**, II, 212.
 21. Chem. Ztg. 1910, **34**, 805, abstr. Chem. Zentr. 1910, **81**, II, 768.
 22. Jap. P. 30009, 1916, abstr. C. A. 1917, **11**, 1754.
 23. J. Soc. Dyers Col. 1910, **26**, 31, abstr. Text. Color. 1910, **32**, 75.
 24. Musterztg. 1872, No. 20, abstr. Dingl. Poly. 1872, **205**, 277, Jahr. Chem. 1871, **24**, 1111, 1872, **25**, 1075, Chem. Tech. Mitth. 1871-2, 47, Poly. Centr. 1872, **38**, 827.
 25. Zts. physik. Chem. 1911, **78**, 209, abstr. J. S. C. I. 1911, **30**, 1309.
 26. Farber. Ztg. 1918, **29**, 97, abstr. C. A. 1919, **13**, 2133.
 27. Leip. Farber. Ztg. **62**, 77, 89, abstr. C. A. 1913, **7**, 1614.
 28. Rev. gen. Mat. Col. 1911, **15**, 194, abstr. J. S. C. I. 1911, **30**, 888, C. A. 1912, **6**, 157.

Süvern,¹ B. Setlik,² E. Thiele,³ Ver. Glanzstoffabriken,⁴ A. Wagner,⁵ Wolfgang,⁶ P. Weyrich,⁷ C. Claessen,⁸ Courtaulds,⁹ and H. Giesler.¹⁰

In addition to the usual artificial threads, the manufacture of artificial tulle,¹¹ lynx hair,¹² and xyloline and textilose,¹³ and especially artificial horse hair, requires the formation of a large filament, usually round, but often flat, as in artificial straw and braid. The simulation of horse hair, especially for dress and millinery trimmings, is an important branch of the synthetic

1. *Färber Ztg.* 1901, **12**, 6; abst. *J. S. C. I.* 1901, **20**, 243; *Text. Colorist*, 1907, **29**, 131; *J. Soc. Dyers Color.* 1901, **17**, 41.
2. *Färben Ztg.* 1902, **121**; abst. *Wag. Jahr* 1902, **48**, II, 558.
3. *Mon. Text. Ind.* 1897, **12**, 331; ind. *Text* 1897, **13**, 148; *Text. Col.* 1897, **33**, 109; *Färber Ztg.* 1897, **33**, 117; *Muster Ztg.* 1897, **46**, 501; *Text. Man.* 1897, **23**, 235. Belg. P. 254161; abst. *Chem. Ztg.* 1913, **37**, 537. D. R. P. 131312, 1901; abst. *Mon. Sci.* 1904, **60**, 104; *Wag. Jahr.* 1902, **48**, II, 470.
4. *Färber Ztg.* 1901, 6; abst. *Wag. Jahr* 1901, **47**, 585; D. R. P. 198008, F. P. 383636.
5. D. R. P. 137255; abst. *Wag. Jahr* 1903, **49**, II, 415. D. R. P. 152432; abst. *Wag. Jahr.* 1904, **50**, II, 417; abst. *Mon. Sci.* 1905, **65**, 328; *Chem. Zts.* 1904, **3**, 800.
6. *Färber Ztg.* **22**, 403; abst. C. A. 1912, **6**, 696.
7. *Färber Ztg.* **25**, 141; abst. C. A. 1914, **8**, 2063.
8. E. P. 6104, 1915; abst. *J. S. C. I.* 1916, **35**, 40. Cf. E. P. 17348, 1914; abst. *J. S. C. I.* 1917, **36**, 131.
9. E. P. 18556, 1914; abst. *J. S. C. I.* 1915, **34**, 957.
10. E. P. 10867, 1914. See also *Englische Wollenwaren Manufaktur*, F. P. 333835, 1903. A. Haack, F. P. 351088; abst. *J. S. C. I.* 1905, **24**, 888. W. Furness, U. S. P. 1338648, 1920. A. Lecœur, Ital. P. 349 47/113253, 1910; abst. *Chem. Ztg.* 1912, **36**, 162.
11. A. Auty, *J. Soc. Dyers Col.* 1912, **28**, 16; abst. C. A. 1912, **6**, 1529. *J. S. C. I.* 1912, **31**, 120. A. Chaplet, *Rev. gen. Mat. Col.* 1911, **15**, 102, abst. *Chem. Ztg. Rep.* 1911, **35**, 250. Gudman, F. P. 305267, 1900. D. Lancé, Belg. P. 234301, 1911. L. Lefevre, *Rev. gen. Mat. Col.* 1911, **15**, 193, abst. C. A. 1911, **5**, 2559; 1912, **6**, 157. J. Mugnier, E. P. 9482, 1901. D. R. P. 148587. K. Suevern, *Kunst.* 1911, **1**, 61; abst. *Wag. Jahr.* 1911, **57**, II, 426. See *Text. Colorist*, 1912, **34**, 85.
12. Lynxhayr Ltd., and W. Dickinson, F. S. P. 998237, 1911; F. P. 426967; E. P. 28358, 1911; abst. *J. S. C. I.* 1911, **30**, 1009. *Kunst.* 1911, **1**, 379. A. and C. Jenner, E. P. 9032, 1911; abst. C. A. 1912, **6**, 2847.
13. E. Claviez, E. P. 11000, 1913; F. P. 458054, 1913; abst. *J. S. C. I.* 1913, **32**, 975, 1006. *J. Soc. Dyers Col.* 1913, **29**, 364; C. A. 1914, **8**, 3503. Deutsch Oesterreichische Textilose Ges., *Kunst.* 1913, **3**, 97. W. Dreaper, *J. Soc. Dyers Col.* 1912, **28**, 178. M. Lambert, *L'Ind. Chim.* 1918, **5**, 34; abst. C. A. 1918, **12**, 1125. A. Leinverber, E. P. 20027, 1911. M. Richard, *Zts. Farben-Ind.* 1910, **9**, 381. J. Sponar, *Kunst.* 1912, **2**, 421, 446; abst. C. A. 1913, **7**, 706. K. Süvern, *Kunst.* 1914, **4**, 108, 1916, **6**, 202, 285; abst. C. A. 1917, **11**, 1308. E. Cadoret, F. P. 256854, 1896. *Must. Ztg.* 1897, **46**, 450. A. Verda, Schweiz. *Wochschr.* **50**, 300; abst. C. A. 1912, **6**, 1206, 2490. In this connection see *Färber Ztg.* 1897, **23**, 167. *Kunst.* 1913, **3**, 59, 206, 1914, **4**, 57. Board Trade J., June 22, 1911; abst. *J. Soc. Dyers Col.* 1911, **27**, 201.

silk industry. These latter filaments are prepared according to the processes as disclosed by J. Battis and A. Goodelt,¹ E. Baumach,² E. Berl and M. Isler,³ B. Borzykowski,⁴ J. Brandenberger,⁵ M. Bruggisser et Cie.,⁶ L. Crespin,⁷ E. Crumiere,⁸ H. Diamanti and H. Champin,⁹ W. Dickinson,¹⁰ G. Dietl,¹¹ Furst Guido Donnersmarcksche Kunstseiden und Acetatwerke,¹² T. Eck,¹³ T. Ehninger,¹⁴ Societe commerciale des crins, Georges Fournier,¹⁵ N. Frank,¹⁶ R. Freerichs,¹⁷ A. Fuchs,¹⁸ F. Gaebele,¹⁹ P. Girard,²⁰ R. Hall and H. Duxbury,²¹ P. Haves,²² A. Herzog,²³ C. Holmes,²⁴ G. Jacober and A. Rabourdin,²⁵ L. Jannin,²⁶ D. Lance,²⁷ L. Lederer,²⁸ H. Knight,²⁹

1. E. P. 13062, 1902. A. Forster, E. P. 21280, 1903, abst. J. S. C. I. 1904, **23**, 184.
2. F. P. 418608, 1909, abst. J. S. C. I. 1911, **30**, 79.
3. E. P. 14216, 1914, abst. J. S. C. I. 1915, **34**, 1049.
4. D. R. P. 262253, 1912, abst. C. A. 1913, **7**, 3444, J. S. C. I. 1913, **32**, 907, Kunst. 1913, **3**, 260. F. P. 424428, abst. Kunst. 1911, **1**, 339.
5. F. P. 436186, abst. Kunst. 1912, **2**, 177. E. P. 4064, 1912, abst. J. S. C. I. 1913, **32**, 358.
6. Swiss P. 10845, 20433. See Text. Man. 1904, **30**, 99.
7. E. P. 27565, 1904, abst. J. S. C. I. 1905, **24**, 513.
8. F. P. 377118, 1907, abst. Mon. Sci. 1908, **69**, 29, 534, 1910, **73**, 445.
9. F. P. 377494, 1906, abst. J. S. C. I. 1907, **26**, 1087.
10. U. S. P. 908237, 1911, F. P. 426967, 1911, abst. J. S. C. I. 1911, **30**, 1009.
11. E. P. 15029, 1905, F. P. 356323, 1905, abst. J. S. C. I. 1906, **25**, 16, 217.
12. E. P. 23683, 1906, D. R. P. 189140, 212954. F. P. 398424, 1909, Swiss P. 47395. Aust. P. 29053. Cf. G. Luxburg, E. P. 1407, 1909, abst. J. S. C. I. 1910, **29**, 208.
13. D. R. P. Ann. E. 19112, 1913, abst. Kunst. 1914, **4**, 220.
14. E. P. 14610, 1906. See Moss, Text. Man. 1903, **29**, 147, 1904, **30**, 13.
15. D. R. P. 239555, 1909; abst. Kunst. 1911, **1**, 456; C. A. 1912, **6**, 2177, Zts. ang. Chem. 1911, **24**, 2230, Chem. Zentr. 1911, **82**, II, 1397.
16. E. P. 22543, 1912.
17. U. S. P. 729749, 1903, abst. Mon. Sci. 1903, **59**, 165, J. A. C. S. 1904, **26R**, 30.
18. F. P. 433956, 1910, abst. J. S. C. I. 1912, **31**, 225, J. Soc. Dyers Col. 1912, **28**, 84, Chem. Ztg. 1912, **36**, 223.
19. E. P. 12506, 1906, abst. J. S. C. I. 1907, **26**, 45.
20. F. P. 430939, 1910, abst. J. S. C. I. 1911, **30**, 1375, Kunst. 1912, **2**, 33.
21. E. P. 16891, 1912, abst. C. A. 1914, **8**, 406.
22. E. P. 187, 1914.
23. Kunst. 1911, **1**, 181, 206. Cf. W. Massot, Chem. Ztg. 1907, **31**, 799.
24. U. S. P. 737256, 1903; E. P. 4379, 1902; abst. J. S. C. I. 1903, **22**, 415, 1043.
25. E. P. 16785, 1895; abst. J. S. C. I. 1894, **13**, 918; 1895, **14**, 706, 873, 801.
26. D. R. P. 183001, 1906.
27. Belg. P. 244303, 1911.
28. U. S. P. 853063, 1907. E. P. 11625, 1903; abst. J. S. C. I. 1909, **28**, 1030. E. and A. Lederer, Aust. Ann. 4048, 1911; abst. Chem. Ztg. 1912,

Societe Anonyme Le Crinoid,¹ F. Lehner,² H. Luxburg,³ E. Marshall,⁴ F. Scholl,⁵ K. Muller, J. Schwarz and M. Scheid,⁶ R. Pawlikowski,⁷ A. Pellerin,⁸ Societe Pichard Brothers,⁹ V. Renard,¹⁰ C. Roux,¹¹ Ruthven,¹² C. Sanlaville,¹³ L. Fessmann,¹⁴ L. Sarason,¹⁵ M. Schall,¹⁶ M. Severen,¹⁷ Societe Anon. des Cellulose Planchon,¹⁸ Hanauer Kunstseidefabrik Akt. Ges.,¹⁹ K. Sueveren,²⁰ F. Todtenhaupt,²¹ Vereinigte Glanzstoff Fabriken,²² Vereinigte Kunstseide Fabriken,²³ and J. Vermeesch.²⁴

Artificial hemp straw, bast and brand used in passementerie

• 36, 367.

- 29 E. P. 1765, 1890, abst. J. S. C. I. 1891, **10**, 264.
- 1 E. P. 21191, 1908, abst. J. S. C. I. 1909, **28**, 1194, J. Soc. Dyers Col. 1909, **25**, 314.
- 2 U. S. P. 852093, 1907, abst. C. A. 1907, **1**, 2189.
- 3 E. P. 1407, 1909, abst. J. S. C. I. 1910, **29**, 208, J. Soc. Dyers Col. 1910, **26**, 66.
- 4 E. P. 29054, 1906.
- 5 U. S. P. 1029639, 1912, abst. C. A. 1912, **6**, 2535, Mon. Sci. 1913, **79**, 161.
- 6 E. P. 3725, 1890, abst. J. S. C. I. 1891, **10**, 539.
- 7 E. P. 16629, 1910, abst. J. S. C. I. 1911, **30**, 1009.
- 8 F. P. 422022, 1912, abst. J. S. C. I. 1912, **31**, 916, J. Soc. Dyers Col. 1912, **28**, 309.
- 9^a F. P. 475793, abst. J. S. C. I. 1916, **35**, 39.
- 10 E. P. 23361, 1901.
- 11 F. P. 392179, 1908, abst. J. S. C. I. 1908, **27**, 1201. F. P. 462657, abst. Kunst. 1914, **4**, 173.
- 12 Text World J. 1916, **51**, No. 12, 25, abst. C. A. 1916, **10**, 1438.
- 13 U. S. P. 1093295, 1914, abst. C. A. 1914, **8**, 2065, J. S. C. I. 1914, **33**, 546, E. P. 21889, 1912, abst. J. S. C. I. 1913, **32**, 531, F. P. 435989, 1911, abst. J. S. C. I. 1912, **31**, 381, Kunst. 1912, **2**, 177.
- 14 D. R. P. 317181, 1918, abst. Chem. Ztg. 1920, **44**, 164.
- 15 F. P. 148429, 1912, abst. J. S. C. I. 1913, **32**, 420.
- 16 Kunst. 1914, **4**, 374, abst. C. A. 1915, **9**, 1977.
- 17 F. P. 368158, 1906.
- 18 F. P. 110721, 1909, abst. J. S. C. I. 1910, **29**, 811.
- 19 F. P. 377326, 1907, abst. Mon. Sci. 1908, **69**, 29, J. S. C. I. 1907, **26**, 1004.
- 20 Farb. Ztg. 1902, **13**, 1, abst. J. S. C. I. 1902, **21**, 249, Wag. Jahr. 1902, **48**, II, 170. Cf. D. R. P. 125309, abst. Wag. Jahr. 1901, **47**, II, 513.
- 21 D. R. P. 170051, 178985, abst. Zts. ang. Chem. 1907, **20**, 370.
- 22 U. S. P. 856857, 1896. E. P. 1284, 1905. F. P. 351206, 1905. D. R. P. 186766, 1904. Aust. P. 32377. E. P. 100631, 1916, 139481, 1920, abst. C. A. 1916, **10**, 2637, 1920, **14**, 2090. D. R. P. 260479, abst. Chem. Ztg. 1913, **37**, 557.
- 23 U. S. P. 680719, 1901, 713999, 1902, 853093, 1907, abst. J. S. C. I. 1907, **26**, 606. E. P. 20461, 20461, 1900, 7520, 1906, abst. J. S. C. I. 1906, **25**, 881. F. P. 303065, 1900, 363782, 1906, abst. J. S. C. I. 1906, **25**, 881. D. R. P. 125309, abst. Wag. Jahr. 1902, **48**, II, 513. D. R. P. 129420, 181784, 1905, abst. Mon. Sci. 1909, **70**, 166, Chem. Zentr. 1907, **78**, II, 110; Chem. Tech. Rep. 1907, **31**, 149; Wag. Jahr. 1907, **53**, II, 392. D. R. P. 184510, 1906. Aust. P. 5195, 8359, 33840. In this connection see D. R. P. Ann. V-10176, 10382, 1911, D. R. P. 267731, 1914, abst. Chem. Ztg. 1912, **36**,

and trimmings, are produced along similar lines and have an established and extensive demand.

In the metallization of yarn and filaments, F. Bayer & Co.,¹ Wederhake,² E. Breuer,³ L. Monty,⁴ E. Schramm,⁵ E. Knecht, A. Perl and P. Spence & Sons,⁶ A. Boyeux and Societe Lizier Buffet et Fils,⁷ are applicable.

In electric lamp filament formation, the artificial silks have long been used, "carbon" filaments being usually some form of cellulose once in solution and afterwards coagulated. This art is covered by the various processes and modifications of H. Albrecht,⁸ W. Bruno,⁹ E. Crumiere,¹⁰ M. Dems,¹¹ P. Girard and C. Buffard,¹² J. Stark, E. Reinger and G. Ludecke,¹³ J. Hartogs,¹⁴ C. Kanazawa,¹⁵ O. Knofer,¹⁶ H. Madden and W. Gibbons,¹⁷ A. Madaillon,¹⁸ C. Muller and D. Wolf,¹⁹ F. Planchon,²⁰ A. Plaissetty,²¹

528, 598, 1913, **37**, 1148. F. P. 438718, 443621, 1912, abst. Chem. Ztg. 1912, **36**, 590, 958. Belg. P. 242387, 252105, abst. Chem. Ztg. 1912, **36**, 350, 1913, **37**, 458. Swiss P. 488831, Chem. Ztg. 1913, **37**, 419. Aust. P. Ann. 3481, 1912, Aust. P. 57715, abst. Chem. Ztg. 1913, **37**, 189, 472.

24. Belg. P. 190677, 1906. O. Silberrad, Hung. P. Ann. S. 5032, 1911.

1. D. R. P. 243068, abst. Wag. Jahr. 1912, **58**, H. 502. F. P. 408470, 1909, Add. June 11, 1910, 415048, 1910, abst. J. S. C. I. 1910, **29**, 624, 1299. Aust. P. 56595, abst. Chem. Ztg. 1913, **37**, 335.

2. Pharm. Centrall. 1906, **47**, 862.

3. D. R. P. 55263, abst. Wag. Jahr. 1891, **37**, 1113.

4. Belg. P. 253706, abst. Kunst. 1913, **3**, 357. Chem. Ztg. 1913, **37**, 458.

5. U. S. P. 823445, 1906.

6. E. P. 25533, 25534, 1911, abst. C. A. 1913, **7**, 1608. J. Soc. Dyers Col. 1912, **28**, 42. F. P. 449801, Ital. P. 395, 151, 128759, 128760, Hung. P. Ann. 6490, abst. Chem. Ztg. 1913, **37**, 228, 728, 996.

7. F. P. 402622, 1908. E. P. 235, 1907, abst. J. S. C. I. 1908, **27**, 158. J. Soc. Dyers Col. 1907, **23**, 62.

8. D. R. P. 178832, abst. Chem. Ztg. Rep. 1907, **31**, 20. Chem. Ind. 1907, **30**, 524. Wag. Jahr. 1907, **1**, 71.

9. D. R. P. 247045, abst. Wag. Jahr. 1911, **57**, H. 143. C. A. 1912, **6**, 2519. Zts. ang. Chem. 1912, **25**, 1309.

10. F. P. 415003, 1910, abst. J. S. C. I. 1910, **29**, 344.

11. Belg. P. 253398, 1913.

12. Belg. P. 247991, 1912.

13. E. P. 12879, 1899. See W. Vieweg, Chem. Ztg. 1907, **31**, 85.

14. U. S. P. 1119155, 1914. Aust. Ann. 6306, 1911, Swiss P. 56329, 1911, abst. Chem. Ztg. 1912, **36**, 1174, 1229.

15. E. P. 16481, 1913, abst. C. A. 1915, **9**, 150.

16. U. S. P. 365832, 367534, 430508, 439882, 516076, 516080, E. P. 11038, 1895, 7429, 12056, 1896, 26381, 1897, 3770, 1898.

17. E. P. 7331, 1910, abst. J. S. C. I. 1911, **30**, 77.

18. F. P. 345012, 1904, abst. J. S. C. I. 1904, **23**, 1206.

19. E. P. 10430, 1912, abst. J. S. C. I. 1913, **32**, 831.

20. E. P. 4956, 1908, abst. J. S. C. I. 1909, **28**, 83.

21. F. P. 321803, 1902. Can. P. 65301, 1899, abst. Mon. Sci. 1903, **61**, 187.

J. Swan,¹ O. Swete and W. Main,² W. Voelker,³ E. Weston,⁴ W. Heseler,⁵ and Julius Pintsch, Akt. Ges.⁶

In contradistinction to the "cellulose" silks previously mentioned, are the "animal" artificial filaments, made from gelatin indurated with formaldehyde, bichromate or tannin, as well as casein, Vandura, albuminoid, and similar filaments. They are all deficient in tensile strength when hardened to the point of required insolubility in water, and are inferior to the cellulose silks from nitrocellulose, cuprammonia and viscose. Their method of manufacture and properties are detailed in the processes of formation as developed by C. Baumann and G. Diesser,⁷ H. Bernstein,⁸ H. Boistesselin and C. Gay,⁹ P. Brosse,¹⁰ H. Chavassieu,¹¹ J. Cooley,¹² S. Cooper,¹³ P. Delahaye,¹⁴ G. Diesser,¹⁵ S. Diesser,¹⁶ W. Dreaper,¹⁷ H. Dunham,¹⁸ J. Eck & Sohne,¹⁹ P.

1. E. P. 5978, 1883. D. R. P. 30291.
2. E. P. 6167, 1886, abst. J. S. C. I. 1886, **5**, 500.
3. E. P. 16653, 1901. Cf. Societe Syndicate Procèdes Rousseau, F. P. 380270, 1907.
4. U. S. P. 264987, 1882. E. P. 4458, 1892; abst. J. S. C. I. 1892, **11**, 291.
5. D. R. P. 319613, 1918; abst. J. S. C. I. 1920, **39**, 480-A.
6. Belg. P. 241072, 1911; abst. Chem. Ztg. 1912, **36**, 292.
7. U. S. P. 976977, 1910; abst. J. S. C. I. 1910, **29**, 1450; C. A. 1911, **5**, 792. E. P. 169, 1909. F. P. 396305, 1908; abst. J. S. C. I. 1909, **28**, 597. Addn. Dec. 2, 1908, abst. J. S. C. I. 1909, **28**, 791. D. R. P. 230394, 1907; abst. C. A. 1911, **5**, 2744; Zts. ang. Chem. 1911, **24**, 430; Chem. Zentr. 1911, **82**, I, 442. D. R. P. 236907, 1909, abst. C. A. 1912, **6**, 1232; Zts. ang. Chem. 1911, **24**, 1583; Chem. Zentr. 1911, **82**, 326.
8. U. S. P. 712756, 1902, abst. J. S. C. I. 1903, **22**, 24.
9. F. P. 403193, 1909; abst. Mon. Sci. 1911, **74**, 154.
10. E. P. 24110, 1908, abst. J. S. C. I. 1909, **28**, 597. See E. P. 15522, 1894.
11. U. S. P. 950435, 1910, 984539, 1911, abst. J. S. C. I. 1909, **28**, 422. E. P. 26155, 1908, 18315, 1910; abst. J. S. C. I. 1911, **30**, 80. F. P. 395402, 1907; Add. 11354, 12620, 1909; abst. J. S. C. I. 1909, **28**, 422; 1910, **29**, 416, 1371. Swiss P. 47266, 1908.
12. E. P. 6385, 1900, abst. J. S. C. I. 1900, **19**, 400, 583, 659, 713. U. S. P. 692631, 1902, 745276, 1903.
13. E. P. 16185, 1910; abst. C. A. 1911, **5**, 2732.
14. Cosmos, 1898, **39**, 672. H. Vittenet, Belg. P. 185553, 1905.
15. E. P. 16615, 16616, 1912; abst. J. S. C. I. 1913, **32**, 835. Aust. P. 63438, 1912.
16. D. R. P. 236302, 1909; abst. C. A. 1912, **6**, 1544; Zts. ang. Chem. 1911, **24**, 1542; Chem. Zentr. 1911, **82**, II, 409; Kunst. 1911, **1**, 339.
17. U. S. P. 625033, 1899; E. P. 11959, 21872, 1908; abst. Wag. Jahr. 1898, **46**, 994. D. R. P. 113786; abst. Jahr. Chem. 1900, **53**, 845; Wag. Jahr. 1900, **46**, 845. See J. S. C. I. 1909, **28**, 1297, Bull. Soc. Chim. 1910, **8**, 524. Belg. P. 190857, 1906.
18. U. S. P. 748709, 1904; abst. J. A. C. S. 1904, **26R**, 362; Mon. Sci. 1904, **60**, 84.
19. D. R. P. Anm. E-15499, 1910. See A. Wagner, D. R. P. 137255, 1901.

Follet and G. Ditzler,¹ P. Forest,² W. Freymuth,³ S. Frohwein,⁴
 • Genthiner Kartonpapierfabrik, Ges.,⁵ M. Gerard,⁶ J. Hartogs,⁷
 A. Helbronner and E. Vallee,⁸ A. Herzog,⁹ H. Heydenhauss, A.
 Bauhegyi and K. Glaser,¹⁰ J. Hubner,¹¹ L. Jannin,¹² R. Knecht,¹³
 H. Jentgen,¹⁴ D. Lance,¹⁵ R. Langhans,¹⁶ E. Meyer,¹⁷ A. Millar,¹⁸
 O. Moh,¹⁹ H. Morin,²⁰ E. Mueller,²¹ J. Mugnier,²² Naamlouze Ven-
 nootschap Hollandsche Zyde Maatschappy,²³ H. Nowak,²⁴ G.

1. E. P. 22753, 1907. F. P. 382859, 1907. D. R. P. 211871, 223294.

Swiss P. 41238. Belg. P. 102328, 195233, 196477, 195495, 1906.

2. F. P. 361759, 1905; abst. J. S. C. I. 1906, **25**, 1144.

3. E. P. 1071, 1911. See R. Formhals, Chem. Ztg. 1919, **43**, 386; abst. C. A. 1920, **14**, 469.

4. E. P. 13698, 1895, abst. J. S. C. I. 1895, **14**, 787, 845, 875.

5. Aust. P. 46655. See J. Wallner, Chem. Ztg. 1910, **34**, 22; abst. Mon. Sci. 1913, **78**, 273.

6. E. P. 2694, 2695, 1887; abst. J. S. C. I. 1887, **6**, 232; 1888, **7**, 54, 127.

7. U. S. P. 1119155, 1914; abst. J. S. C. I. 1915, **34**, 25. E. P. 16720, 1911; abst. J. S. C. I. 1912, **31**, 123; C. A. 1913, **7**, 265; J. Soc. Dyers Col. 1912, **28**, 120. D. R. P. 237744, 1910; abst. J. S. C. I. 1911, **30**, 1249. Swiss P. 56329, 1911.

8. E. P. 20548, 1908. F. P. 361796, 1905, abst. J. S. C. I. 1906, **25**, 1227; D. R. P. 197250, 202265. Aust. P. 40676, 40613. Swiss P. 41005, 41555, 1908.

9. Chem. Ztg. 1906, **30**, 166; abst. Wag. Jahr. 1906, **52**, II, 394.

10. Aust. P. Ann. 5091, 1908. See J. Vermeesch, Belg. P. 184228, 1905.

11. Lesage, F. P. 382272, 1906, abst. J. S. C. I. 1908, **27**, 235.

12. Belg. P. 236549, 1911. E. P. 14559, 19106, 1910, abst. J. S. C. I. 1911, **30**, 888, 1112.

13. F. P. 342112, 1904, Add. 7824, 19107, abst. J. S. C. I. 1904, **23**, 899; 1907, **26**, 1237.

14. Wag. Jahr. 1899, **45**, 944. See also Mon. temt 1897, **41**, 214.

15. D. R. P. 259421; abst. Kunst. 1913, **3**, 219.

16. F. P. 435156, 1910, Add. Jan. 28, 1911, abst. J. S. C. I. 1912, **31**, 328, 485; Kunst. 1912, **2**, 234.

17. Ind. Text. 1897, **13**, 239. See A. Chaplet Rev. gen. Mat. Col. **14**, 14.

18. F. P. 322301, 1902. See Merck's Rep. 1909, **18**, 44.

19. U. S. P. 594888, 1897; 625345, 1899. E. P. 15522, 1894, 2713, 1897; 6700, 1898. D. R. P. 68225, 109682, abst. Wag. Jahr. 1896, **42**, 977; Belg. P. 126544, 1897; 138699, 1898. Swiss P. 12728, 1896; 13972, 18942. Wag. Jahr. 1899, **45**, 943. See P. Delahaye, Cosmos, 1899, **40**, 450.

20. D. R. P. 204868, abst. Wag. Jahr. 1909, **55**, II, 516; Chem. Zentr. 1909, **80**, I, 610; Chem. Ztg. Rep. 1909, **33**, 24.

21. F. P. 388441, 1907; abst. J. S. C. I. 1908, **27**, 911, Mon. Sci. 1909, **70**, 110.

22. D. R. P. 222777, 1909, abst. Wag. Jahr. 1910, **56**, II, 481; Zts. ang. Chem. 1910, **23**, 1744; Chem. Zentr. 1910, **81**, II, 252, Jahr. Chem. 1910, **63**, II, 425; Text. Colorist, 1912, **34**, 64.

23. E. P. 9482, 1901, abst. J. S. C. I. 1902, **21**, 857. D. R. P. 148587; abst. Chem. Ztg. 1904, **28**, 138.

24. F. P. 431052, 1911; abst. J. S. C. I. 1911, **30**, 1376. E. P. 14266, 1911; abst. J. S. C. I. 1912, **31**, 485. D. R. P. 190838, 1907; 236908, 1910; abst. C. A. 1912, **6**, 1232; J. S. C. I. 1911, **30**, 1050; Zts. ang. Chem. 1911, **24**, 1583; Chem. Zentr. 1911, **82**, II, 327; Wag. Jahr. 1911, **57**, II, 423. Belg.

Onsager,¹ H. Peters,² W. Plinatus,³ V. Renard,⁴ L. Sarason,⁵ Akt. Gesellschaft f Anilin Fabrikation,⁶ A. Spitteler,⁷ Societe Anonyme Le Crinoid,⁸ Soc. anon. pour l'Étude Ind. de la Soie Serret,⁹ Societe Jules Jean et Cie and Georges Raverat,¹⁰ C. Soulier,¹¹ R. Strehlenert,¹² Societe Tapissier,¹³ H. Timpe,¹⁴ F. Todtenhaupt,¹⁵ H. Turgard,¹⁶ Societe la Soie Artificielle,¹⁷ Actien Gesellschaft f Anilin Fabrication,¹⁸ G. Buret,¹⁹ and J. Hunter.²⁰

- P. 236527, 1911 Hung. Ann. H-4243, 1911 Aust. Ann. A-5119, 1911
 • Swiss P. 57738, 1911, abst. Chem. Ztg. 1912, **36**, 162. Ital. P. 362/69/118665, 1911, abst. Chem. Ztg. 1912, **36**, 775
 21 U. S. P. 806371, 1906. See Text. Man. 1903, **29**, 209.
 1 E. P. 24738, 1913, abst. J. S. C. I. 1915, **34**, 25.
 2 E. P. 870, 1910, abst. J. S. C. I. 1911, **5**, 206.
 3 E. P. 9616, 1910, F. P. 122116, 424228, abst. Kunst. 1914, **4**, 286.
 4 E. P. 23361, 1901, F. P. 317444, 1904.
 5 E. P. 21586, 1912. F. P. 448129, 1912, abst. J. S. C. I. 1913, **32**, 420, Kunst. 1913, **3**, 95. D. R. P. 260842, 1912, abst. C. A. 1913, **7**, 3237; J. S. C. I. 1913, **32**, 748, Kunst. 1913, **3**, 220, 275. D. R. P. 258810, 1912, abst. C. A. 1913, **7**, 2692, Kunst. 1913, **3**, 140. Swiss P. 59641, 1912.
 6 F. P. 355805, 1905; abst. J. S. C. I. 1905, **24**, 1226, 1249.
 7 E. P. 17258, 1902. Cf. E. P. 24712, 1897; 17657, 1899, 15202, 1898. J. S. C. I. 1903, **22**, 815.
 8 U. S. P. 917715, 1910. F. P. 401741, 1908, abst. J. S. C. I. 1909, **28**, 1121. See also A. Lecoenr. E. P. 14113, 1908.
 9 F. P. 363949, 1906, abst. J. S. C. I. 1906, **25**, 980.
 10 F. P. 315138, 1901, abst. J. S. C. I. 1904, **23**, 1231, 1906, **25**, 773.
 11 F. P. 104795, 1909, abst. J. S. C. I. 1910, **29**, 227.
 12 Belg. P. 126262, 1897. Compare Belg. P. 186015, 1905.
 13 F. P. 419855, 1912, abst. Kunst. 1913, **3**, 177.
 14 E. P. 14266, 1911, abst. J. S. C. I. 1912, **31**, 485. F. P. 356508, 1905, abst. J. S. C. I. 1906, **25**, 16. D. R. P. 275016, 1913; abst. C. A. 1914, **8**, 3375, Kunst. 1914, **4**, 260. Cf. D. R. P. 236908, 1910, abst. J. S. C. I. 1911, **30**, 1050. Belg. P. 186015, 1905.
 15 U. S. P. 836788, 1906, abst. J. S. C. I. 1907, **26**, 91. E. P. 25296, 1904, abst. J. S. C. I. 1905, **24**, 1063. F. P. 356404, 1905. D. R. P. 170051, abst. Wag. Jahr. 1906, **52**, 11, 393. D. R. P. 178985, 182574, abst. Chem. Ztg. Rep. 1907, **31**, 186. D. R. P. 183317; abst. C. A. 1908, **2**, 344, Zts. ang. Chem. 1907, **20**, 1542, Chem. Zentr. 1907, **78**, II, 1034, Chem. Ztg. Rep. 1907, **31**, 210, Wag. Jahr. 1907, **53**, II, 399, Mon. Sci. 1909, **70**, 166. D. R. P. 203820, abst. C. A. 1909, **3**, 724, J. S. C. I. 1908, **27**, 1201, Zts. ang. Chem. 1909, **22**, 504, Chem. Zentr. 1908, **79**, II, 1835, Chem. Ztg. Rep. 1908, **32**, 619, Chem. Ind. 1908, **31**, 739, Wag. Jahr. 1908, **54**, II, 586. Aust. P. 28290. Belg. P. 185997, 1905. Text. Colorist, 1906, **28**, 95.
 16 F. P. 314815, 1904, abst. Mon. Sci. 1907, **67**, 599, J. Soc. Dyers Col. **36**, 20, 292, J. S. C. I. 1904, **23**, 1212.
 17 E. P. 9196, 1915, Swiss P. 74231, 1917, abst. C. A. 1916, **10**, 3159, 1917, **11**, 1902.
 18 F. P. 355805, 1905. See Alsacienne de Constructions Mecaniques, E. P. 113970, 1918, abst. J. S. C. I. 1918, **37**, 461-A.
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Many other ideas in artificial silk formation¹ have been

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advanced, but the details as contained in the foregoing references include the more salient points which have been advanced

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as materially contributing to the development of this highly specialized and mechanically intricate art.

For the distinction between, and differentiation of natural and artificial silks; the action of reagents upon the individual and collective filaments; the microscopical, polariscopic, and chemical differentiation; the subjoined references will furnish detailed information.¹ The various uses for these products,² and the

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statistics of production are indicated in the two notes below.

Cuprammonium Artificial Filaments.¹ There has already been described in this volume the action of cuprammonium solutions on cellulose (pp. 68-79), their physical constants (pp. 79-

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1. A. Colin, rev. gen. chim. pure appl. 1909, **12**, 98. J. Gilpin, Amer. Chem. J. 1910, **43**, 469. M. Richard, Zts. Faerben-Ind. **9**, 361. Zts. ang. Chem. 1908, **21**, 509, Wag. Jahr. 1908, **54**, II, 371. For report on Swiss exports of artificial silk see J. S. C. I. 1920, **39**, 200-R.

85), and their commercial applications (pp. 85-91), this topic having specifically to do with the commercial applications in filament formation, the details of which are elaborated in Volume IV of this series.

The methods of cuprammonium cellulose formation designed especially for filament manufacture are detailed in the processes of Societe anon. la Soie Nouvelle,¹ P. Spence & Sons,² W. Vieweg,³ H. Bernstein,⁴ E. de Haën Chemische Fabrik List,⁵ G. Guadagni,⁶ T. Eck,⁷ and B. Borzykowski,⁸ W. Hachmel and M. Mugdan,⁹ P. Kraus,¹⁰ W. Traube,¹¹ A. Brodbeck,¹² D. Lance,¹³ La Soie Artificielle du Nord,¹⁴ P. Germain,¹⁵ M. Battegay and T. Volz,¹⁶ K. Biltz,¹⁷ and Donnersmark'sche Kunstseiden und Acetatwerke.¹⁸

1. F. P. 369673, 1906; U. S. P. 850695, 1907. Cf. J. Vermeesch, E. P. 20408, 1906; abst. J. S. C. I. 1907, **26**, 107.

2. D. R. P. 264951, 264952, 1912; abst. Chem. Ztg. 1913, **37**, 1124, 1125.

3. Aust. Ann. 2841, 1909; abst. Chem. Ztg. 1913, **37**, 1384.

4. D. R. P. 248303, 1910; Swiss P. 53440, 1910; Aust. Ann. 5706, 1910; abst. Chem. Ztg. 1912, **36**, 185, 308, 661, 1913, **37**, 326.

5. E. P. 27835, 1911; abst. Chem. Ztg. 1912, **36**, 478. D. R. P. 251244, 1911; abst. C. A. 1913, **7**, 267; Zts. ang. Chem. 1912, **25**, 2381; Wag. Jahr. 1912, **58**, II, 442; Kunst. 1912, **2**, 379. F. P. 456968, 1911; 440967, 1912; abst. Chem. Ztg. 1912, **36**, 406, 826; Belg. P. 241649, 1911; 245524, 1912; abst. Chem. Ztg. 1912, **36**, 350, 909. Holl. P. Ann. 586; abst. Chem. Ztg. 1913, **37**, 942. Aust. P. Ann. P. 4339, 1912; abst. Chem. Ztg. 1913, **37**, 387. Ital. P. 381430, 124585; abst. Chem. Ztg. 1913, **37**, 200. E. P. 441063, 1912; abst. Chem. Ztg. 1912, **36**, 752. E. P. 4610, 1912; F. P. 15861, Add. to 440967, 1912; abst. Chem. Ztg. 1912, **36**, 1083, 1090.

6. U. S. P. 977863, 978878; E. P. 1265, 12253, 1908; F. P. 386339, 1908; D. R. P. 216669; Swiss P. 42305. Ital. P. 408210, 130969, 1912; Aust. P. 51799, 1910; abst. Chem. Ztg. 1912, **36**, 10, 1913, **37**, 1384.

7. D. R. P. 240082; abst. C. A. 1912, **6**, 2169; Chem. Zentr. 1911, **82**, II, 1567; Chem. Ztg. 1912, **36**, 327; Chem. Ztg. Rep. 1911, **35**, 576; Kunst. 1911, **1**, 154; Wag. Jahr. 1911, **57**, II, 117; Zts. ang. Chem. 1911, **24**, 2334. D. R. P. Ann. E-18037; abst. Chem. Ztg. 1913, **37**, 996.

8. Ital. P. 129266; abst. Chem. Ztg. 1913, **37**, 1026. Russ. P. 54958, Span. P. 54237. Hung. Ann. B-6257; abst. Chem. Ztg. 1913, **37**, 700. See page 71, note 4. D. R. P. 262263; abst. C. A. 1913, **7**, 3114; Wag. Jahr. 1913, **59**, II, 443; Chem. Ztg. 1913, **37**, 770.

9. Zts. ang. Chem. 1920, **33**, 35; abst. C. A. 1920, **14**, 1946.

10. Neue Faserstoffe 1919, **1**, 266; abst. J. S. C. I. 1920, **39**, 329-A. See also J. S. C. I. 1919, **38**, 895-A.

11. U. S. P. 1064260, 1913; abst. Chem. Ztg. 1913, **37**, 785. Aust. P. Ann. 10798, 1911; abst. Chem. Ztg. 1912, **36**, 958. D. R. P. 245575, 1911; 252661; abst. Chem. Ztg. 1912, **36**, 1174.

12. E. P. 18119, 1890; abst. J. S. C. I. 1890, **9**, 1086.

13. Addn. 15008 to F. P. 435156, 1911; abst. J. S. C. I. 1912, **31**, 328, 485; Mon. Sci. 1913, **79**, 14; Chem. Ztg. 1913, **36**, 406.

14. F. P. 437815, 1911; abst. Chem. Ztg. 1912, **36**, 544.

15. Belg. P. 180718, 1905.

16. Bull. Soc. Chim. 1920, **17**, 537.

17. D. R. P. 311877, 1917; abst. Kunst. 1919, **9**, 180.

18. Belg. P. 195452, 1906. D. R. P. Ann. V-9551, 1910; abst. Chem.

In the coagulation of the solution after formation of threads, the processes of Compagnie Francaise des Applications de la Cellulose,¹ J. Delpech,² G. Pawlikowski,³ E. Legrand,⁴ J. Foltzer,⁵ Glanzfäden Akt. Ges.,⁶ and A. Lecoeur,⁷ are especially applicable.

In actual filament formation, the patented ideas of A. Gadomsky,⁸ T. Don and A. Wright,⁹ L. Despeissis,¹⁰ and A. Galibert,¹¹ may be considered as preliminary to the general methods of cuprammonium silk formation. Among the latter, a general survey of the chemical processes and mechanical features involved may be obtained by reference to the publications of E. Mertz,¹² Societe Generale de la Soie Artificielle Linkmeyer,¹³ Rheinische Kunstseide Fabrik, A. G.,¹⁴ Societe Anon. LeCrinoid,¹⁵ Societe Francaise de la Viscose,¹⁶ E. Thiele,¹⁷ Vereinigte Glanzstoff Fabriken A. G.,¹⁸ Hanauer

Ztg. 1912, **36**, 958.

1. U. S. P. 1027680, 1027689, 1912; E. P. 11714, 1911; abst. C. A. 1912, **6**, 1989; J. S. C. I. 1912, **31**, 428, 584. F. P. 440776, 1911; abst. Chem. Ztg. 1912, **36**, 765. D. R. P. Ann. C-20719, 1911; abst. Chem. Ztg. 1912, **36**, 751. Aust. P. 54428, 1912; abst. Chem. Ztg. 1912, **36**, 478, 948; 1913, **37**, 941. U. S. P. 1062222, abst. Chem. Ztg. 1913, **37**, 712.
2. F. P. 437014, 1911; abst. Chem. Ztg. 1912, **36**, 468.
3. D. R. P. 248172, 1910; abst. Chem. Ztg. 1912, **36**, 661.
4. F. P. 445896, Addn 17170; abst. Chem. Ztg. 1913, **37**, 644. Ital. P. 391/106/127358, abst. Chem. Ztg. 1913, **37**, 953. D. R. P. 250357, 1911; abst. Chem. Ztg. 1912, **36**, 925, 1206.
5. F. P. 353973, 369402, 1906; abst. J. S. C. I. 1907, **26**, 106. D. R. P. 165577.
6. Swed. P. 44992, 1919; abst. C. A. 1920, **13**, 1446. E. P. Appl 16075, 1920; abst. J. S. C. I. 1920, **39**, 504-A. E. P. 145035, 1920.
7. D. R. P. 185294; abst. Mon. Sci. 1909, **71**, 167; Chem. Zentr. 1909, **78**, II, 1035; Chem. Ztg. Rep. 1907, **31**, 303; Jahr. Chem. 1905-08, I, 3124; Wag. Jahr. 1907, **53**, II, 393; Zts. ang. Chem. 1907, **20**, 1542. Ital. P. 349/47/113253.
8. E. P. 3965, 1910, abst. J. S. C. I. 1911, **30**, 137.
9. E. P. 970, 1872.
10. F. P. 203741, 1890. Inasmuch as the patent of Depeissis, although canceled in 1892 on account of non-payment of the renewal fees, remains as a document, the legal value of the Pauly patents is a debatable question.
11. F. P. 440846, 1911; abst. Mon. Sci. 1913, **77**, 181; J. Soc. Dyers Color. 1912, **28**, 309; J. S. C. I. 1912, **31**, 811; Chem. Ztg. 1912, **36**, 826.
12. Swiss P. 35642. British Cellulose Syndicate, Ltd., and V. Mertz, D. R. P. 250396, 1910, abst. Chem. Ztg. 1912, **36**, 1005.
13. U. S. P. 1022097, 1062106, abst. Chem. Ztg. 1912, **36**, 618; 1913, **37**, 700. E. P. 14655, 1907; abst. J. S. C. I. 1908, **27**, 278. F. P. 356404; D. R. P. Ann. L. 32503. India P. Appl. 214, 215, 1905.
14. Aust. P. 54260, 1912; abst. Chem. Ztg. 1912, **36**, 925.
15. U. S. P. 947715, 1910; F. P. 401741. Abst. Mon. Sci. 1910, **73**, 303, 445, 1911, **75**, 153.
16. E. P. 7302, 1909; abst. J. S. C. I. 1909, **28**, 844.
17. Aust. P. 27675 35264. Belg. P. 254161, 1913. F. P. 334507; D. R. P. 148889, 1902; abst. Chem. Centr. 1904, **75**, I, 772. See pages 89, 90.
18. U. S. P. 1023548, 1911; abst. Chem. Ztg. 1912, **36**, 751. E. P.

Kunstseide Fabrik,¹ P. Friedrich,² G. Ditzler,³ J. v. Diggelen,⁴ R. Valette,⁵ and G. Vie.⁶

Analogous uses for cuprammonium cellulose solutions are in the manufacture of artificial corks,⁷ incandescent mantles,⁸ artificial leather,⁹ coating threads,¹⁰ vulcanized fiber,¹¹ artificial stone,¹² artificial horse hair,¹³ waterproofing fabrics,¹⁴ and cello-yarn.¹⁵

Pyroxylin Plastics, Celluloid, Substitutes. Section Six (see

- 17502, 17503, 1902 E. P. 5553, 1913, abst. C. A. 1914, **9**, 2949, J. S. C. I. 1918, **37**, 161. F. P. 317094, 1901, 323474, 351276, 455011, 1913, abst. J. S. C. I. 1913, **32**, 986. D. R. P. 200023, 1907, abst. Chem. Zentr. 1908, **79**, II, 466. D. R. P. 268261, 1912; abst. C. A. 1914, **8**, 1668; Kunst. 1913, **3**, 459; Chem. Ztg. 1913, **37**, 1489. Hung. Ann. G. 3866, 1913, abst. Chem. Ztg. 1913, **37**, 1125. Ital. P. 405'239 131889, 1913, abst. Chem. Ztg. 1913, **37**, 1334. Aust. P. Ann. 9230, 9730, 1910, Aust. P. 54819, abst. Chem. Ztg. 1912, **36**, 10, 1913, **37**, 481. Belg. P. 207181, 1908, 231279, 1910, 242387, 1912. F. P. 454011; D. R. P. 259816, Swiss P. 62315, 1913, abst. Chem. Ztg. 1913, **37**, 495, 606, 1442. Holl. P. 4927, Chem. Ztg. 1920, **44**, 429.
1. D. R. P. 260650; Ital. P. 393'222 128358, abst. Chem. Ztg. 1913, **37**, 578, 953. U. S. P. 1066785, abst. C. A. 1913, **7**, 3031, Chem. Ztg. 1913, **37**, 942.
2. E. P. 17967, 1908, Aust. P. 38809, Swiss P. 40972. See pages 77, 83.
3. D. R. P. 244510, 1911, abst. Chem. Ztg. 1912, **36**, 236.
4. Can. P. 175089, 1917. See A. Levallois, Compt. rend. 1885, **100**, 450, abst. Jahr. Chem. 1885, **38**, 340, J. C. S. 1885, **48**, 369, 500.
5. Belg. P. 180590, 1904.
6. Ind. Chim. 1920, **7**, 115; abst. C. A. 1920, **14**, 2088.
7. L. Pink, U. S. P. 1036446, 1056447, 1913. E. P. 2455, 1911, abst. J. S. C. I. 1911, **30**, 1376. D. R. P. 240563, abst. J. S. C. I. 1912, **31**, 67.
8. A. Muller, Zts. ang. Chem. 1906, **19**, 1810, abst. Chem. Zentr. 1906, **77**, 1693. Deutsche Gasgluhlicht, A. G., E. P. 116103, 1918; abst. C. A. 1918, **12**, 1931. E. P. 3606, 1907; abst. J. S. C. I. 1908, **27**, 157. D. R. P. Ann. M-47935; abst. Chem. Ztg. 1913, **37**, 430.
9. H. Matheson, U. S. P. 1316913, 1919, abst. C. A. 1919, **13**, 3038, J. S. C. I. 1919, **38**, 836-A.
10. C. Vanderkleed and J. Brewer, U. S. P. 1269340, 1916, abst. J. S. C. I. 1918, **37**, 687-A.
11. E. Krusche, E. P. 8164, 1899; abst. J. S. C. I. 1899, **18**, 756.
12. L. Grote, U. S. P. 464'20, 1891, abst. J. A. C. S. 1891, **13**, 299.
13. E. P. 22422, 1906; abst. J. S. C. I. 1907, **26**, 574. E. P. 18164, 1907; 2794, 6766, 7126, 1908; abst. J. S. C. I. 1907, **26**, 112, 1908, **27**, 682. F. P. 361048, 1905, 369635, 1906; 375827, 1907, 377118, Addn. thereto 9067, 1908; abst. J. S. C. I. 1906, **25**, 691; 1907, **26**, 112, 922, 1908, **27**, 977. D. R. P. 187263; abst. Chem. Zentr. 1907, **78**, II, 814, Jahr. Chem. 1905-08, II, 990; Chem. Ztg. Rep. 1907, **31**, 423; Chem. Ind. 1907, **30**, 413, 1907, **53**, 391. D. R. P. 201915, abst. Wag. Jahr. 1908, **54**, II, 450, C. A. 1909, **3**, 375, Zts. ang. Chem. 1908, **21**, 2334; Chem. Zentr. 1908, **79**, II, 1142, Jahr. Chem. 1905-08, II, 989; Chem. Ztg. Rep. 1908, **32**, 513, Chem. Ind. 1908, **31**, 654; D. R. P. 228504; abst. C. A. 1911, **5**, 2039, Jahr. Chem. 1910, **63**, II, 427; Chem. Zentr. 1910, **82**, II, 1791. See pages 86 and 92, Belg. P. 201751, 1907.
14. J. Williams, U. S. P. 731002, 1903, abst. J. A. C. S. 1904, **26R**.
15. Cf. J. Foltzer and E. Weiss, Swiss P. 37584.
16. Kunst. 1919, **9**, 138.

p. 2381). The historical development of the pyroxylin plastics as briefly developed herein, is divided into the following thirteen sub-sections, with 119 separate topics, as follows:

1. *Historical* (2665-2669). Parkesine (2660); xylonite (2662); Hyatt brothers (2663).

2. *Manufacture of Pyroxylin Plastics* (2669-2674). General (2670); bleaching (2671); pulping (2672); preparation of camphor (2672); mixing nitrocellulose and camphor (2673); stabilizers (2673); dehydration (2673); solvent recovery (2673); converting into plastic (2673); seasoning (2673); drying (2673); denitration (2673); manufacture by intense cold (2674); other processes (2674).

3. *Artificing* (2675-2691). Softening (2675); moulding (2677); cutting (2679); powdering (2679); polishing sheets (2680); inlaying (2680); dyeing (2681); manufacture of sheets (2682); stained sheets as substitutes for glass (2683); veneering with pyroxylin (2681); embossing (2685); open seam coverings (2685); lining hollow articles (2686); coating articles with celluloid (2686); celluloid rods and tubes (2688); lining pitchers (2690); mounting stones in celluloid (2690); mounting metals (2690); depositing gold or silver on celluloid (2690); decorating (2691); celluloid lacquers and cements (2691).

4. *Manufacture of Celluloid Articles* (2691-2701). General (2691); instruments (2695); penholders (2695); pens (2696); tooth-picks (2696); ink for writing on celluloid (2696); pipes (2696); cutlery (2696); cartridges (2697); emery wheels (2697); bicycles and motor cars (2698); electrical industries (2699); labels (2701).

5. *Articles of Ornament and Adornment* (2701-2712). Head coverings (sweat pads, hat stiffeners, helmets and ear drums) (2701); face protectors (2703); spectacles (2703); studs (2703); celluloid eyelets (2704); buttons, button holes (2705); collars, cuffs, shirt bosoms (2706); necktie retainers (2708); shoes (2709); stays, stiffeners (2709); whalebone (2710); threads and fabrics (2710); wearing apparel (2711); umbrella and other handles (2712); jewelry (2712); fans (2712).

6. *Toilet Articles*. Brushes (2713); combs (2713); mirrors (2713); trays, dishes and boxes (2713); hairpins (2714); tooth brushes (2714); manicure articles (2715).

7. *Celluloid as Imitative Material* (2716-2722). Ivory (2718); horn (2719); pearl (2720); coral (2720); meerscham (2720); jade

and jasper (2721); tortoise shell (2721); amber (2721); marble and artificial stone (2721); onyx (2721); mosaic (2721); jet (2721); bony (2722).

8. *Solid and Hollow Balls* (2722-2728). Hollow, tennis, ping-pong balls (2722); golf and similar balls (2724).

9. *Games, Toys and Puzzles* (2728-2730). Toys, games, puzzles (2728); playing cards (2729); dolls (2729).

10. *Musical Instruments* (2729-2738). Musical instruments (2729); phonographs (2731).

11. *Celluloid in Medicine, Surgery, Orthopedics, Dentistry and Optics* (2738-2744). Dentistry (2738); surgery (2740); bandages (2742); orthopedics (2743); artificial eyes (2743); optics (2744).

12. *Celluloid in the Printing Art* (2744-2755). Printing (2744); printing blocks, clichés, process work (2746); photography (2748).

13. *Miscellaneous Applications* (2755-2779). Recovery of celluloid (2755); properties of pyroxylin plastics (2756); analysis of celluloid (2758); unflammable pyroxylin plastics (2759).

Insofar as practicable these topics have been developed from the historical viewpoint.

Development of the Pyroxylin Plastic Industry.¹ Celluloid may be properly regarded as a solid colloidal solution of cellulose

1. For résumé of artificial plastics see F. Beltzer, *Mon. Sci.* 1908, **63**, 529, 648; 1909, **70**, 145, 262. See also *Dingl. Poly.* 1880, **235**, 203, 1881, **239**, 62; *Wag. Jahr.* 1878, **24**, 1162; 1881, **27**, 949; M. Turin, *Le Génie Civil*, 1904, **44**, 152, 170, 190. For "History of Celluloid Industries" see *Gum. Ztg.* **14**, 845, and A. Klein, *Zts. ang. Chem.* 1907, **20**, 610. For general articles on celluloid and pyroxylin plastic manufacture, see Hann W. Bl. 1879, 779; *Iron Age*, 1879, **23**, No. 21; *Gew. Bl. Schw.* 1879, **4**, 160; *J. Frankl. Inst.* 1879, **107**, 334; *Papier Ztg.* 1879, **4**, 254; *Orgelb.* 1880, **2**, 255; *Ind. Ztg.* 1880, **21**, 65; *Techniker*, 1880, **2**, 74, 102; *Tischl. Ztg.* 1880, **7**, 71; *Dingl. Poly.* 1880, **235**, 203; *Nature*, 1880, **22**, 370; *Gew. Ztg.* 1880, **45**, 143; *Man. Build.* 1880, **12**, 7; *Mon. Sci.* 1880, **24**, 696; *Papier Ztg.* 1880, **5**, 195; *Sci. Am.* 1880, 3617; *Hutm. Ztg.* 1880, No. 13, p. 14; *Wahl. Bull. Musee*, 1880, **77**, 101; *De Loas, Tijdschr. nijv.* 1880, **43**, 385; *Sadtler, Inv.* 1886, **1**, 57; *J. Buchdr.* 1887, **54**, 870; *Eisen Ztg.* 1887, **8**, 664; *Z. Pap.* 1887, **1**, 724; *Iron Age*, 1887, **39**, No. 2; *W. Wahl, J. Frankl. Inst.* 1887, **108**, 402; *Chem. Ztg.* 1887, **3**, 35; *Engl. Mech.* 1887, **23**, 154; *Poly. Notizbl.* 1887, **34**, 249; *Z. Bursten*, 1891, **14**, 257; *J. S. C. I.* 1891, **10**, 571; *Dréna, Inv. nouv. chim.* 1892, 289; *Z. Drechsler* 1892, **15**, 206; 1896, **15**, 449; *Maschinenb.* 1892, **27**, 14; *Hogben, Gas Light*, 1892, **57**, 77; *Schuh. Ind.* 1896, **22**, 2; *Gum Ztg.* 1896, p. 22; *Stubling, Celluloid*, 1902, No. 2, p. 6; *L. Andes, Chem. Ztg.* 1902, **26**, 475; *Margosches, Ceff. Ind.* 1903, p. 25; *Whitehouse, Le Gén. Civ.* 1903, **42**, 252; *Margraf, Z. Drechsler*, 1905, **28**, 175; *Dhommee, Rev. tech.* 1905, **28**, 372; *Celluloid*, 1907, **8**, 27; *Stubling, Ibid.*, p. 107; *Z. Bürsten*, 1907, **26**, 557; *Ibid.*, 1908, **27**, 355; *Chem. Ztg.* **3**, 35; *Sci. Am.* **46**, 225; *Eng. Mechanic and World of Sci.* **29**, 154; *Poly. Notizbl.* 1879, **34**, 249; *Iron Age*, **23**, 21; **24**, 26; *J. Frankl.*

nitrate and camphor, the process of manufacture comprising conversion of cellulose ester and camphor into a celluloid gel

Inst 1879, **107**, 334; Papier Ztg' **4**, 254. For "Manufacture of Celluloid Accumulators," see Winkler, Crompton and Howell, Dingl. Poly., 1893, **290**, 277, Iron Age, 1887, **24**, No 26. For preparation of the Ribbe accumulator (thin plates covered on both sides with perforated celluloid sheets) see El Anz, 1898, **15**, 141. For manufacture of celluloid mud guards, see Ind Rubber, 1897, **14**, 302. L. Andes, Neue Erfind. Erfahr. 1892, **19**, 204. Chem. Ztg. 1903, **27**, 218, abst. Chem. Centr. 1903, **74**, I, 902. J. Arms, Ber. 1889, **22**, 75. C. v. Babo, Wag. Jahr. 1855, **1**, 140; Horn's Phot. J. 1855, No 9, 10, Dingl. Poly. 1855, **136**, 381; Poly. Centr. 1855, **21**, 1322; Poly. Notizbl. 1855, **10**, 241. Bardy, Bull. Soc. Franc. Phot. 1890, **6**, II, 68. L. Backland, J. Ind Eng. Chem. 1914, **6**, 90; abst. C. A. 1914, **8**, 1203. F. Beltzer, Mon. Sci. 1908, **68**, 648; 1910, **72**, 145, 289; Chem. Centr. 1908, **79**, II, 1475, Jahr. Chem. 1910, **63**, 428. F. Brémond, Bull. Soc. Rouen, 1884, **12**, 520. E. Bentinger, Kunst. 1911, **1**, 10. F. Böckmann, Dingl. Poly. 1877, **224**, 341, 661; **225**, 620, 1881, **239**, 62; Mon. Sci. 1881, **23**, 241; Chem. Tech. Rep. 1881, **20**, I, 86. Erfind. Erfahr. 1900, **33**, 345. G. Bonwitt, Zts. ang. Chem. 1914, **27**, I-A; C. A. 1914, **8**, 1514. A. Brown, J. C. S. 1886, **49**, 432. G. Buchner, Bayer Ind. Gewer. 1890, **22**, 501. H. Chauvet, Bull. Technologique, 1912, No 5, 649. J. Clouet, Mon. Ind. Belg. 1877, 158, Bull. Soc. Ind. Rouen, 1877, 36; Dingl. Poly. 1877, **224**, 341; **225**, 520, **226**, 646, Pap. Ztg. 1877, 462, 660; Jahr. Chem. 1877, **30**, 1223, Chem. News, 1877, **36**, 54. Despaquis, Bull. Soc. Franc. Phot. 1882, **28**, 36. G. Bouborts, Chem. Ind. 1908, **31**, 630. L. Duchesne and E. Michel, Rev. d'hyg. Par. 1882, **4**, 1011. A. Edwards, Chem. News, 1895, **71**, 40; 1896, **74**, 257; Zts. anal. Chem. 1896, **35**, 560. L. Faucher, Rev. d'hyg. Par. 1880, **11**, 522. S. Ferenczi, Zts. ang. Chem. 1899, **12**, 51; Chem. Centr. 1899, **70**, I, 573. Fortier and David, Les Mondes, 1881, **55**, 386. J. Frydender, Rev. prod. Chim. 1918, **21**, 50, C. A. 1918, **12**, 1690. S. Halen, Kunst. 1914, **4**, 329, C. A. 1915, **9**, 148. Hansen, Zts. Reprod. 1905, **7**, 77. H. Hinterstoisser, Wien klin. Wochenschr. 1894, **7**, 63. J. Hyatt, F. P. 96768, 1872; Bull. Soc. Chim. 1874, **21**, 287, Ber. 1874, **7**, 1028, Wag. Jahr. 1874, **20**, 424, Chem. Tech. Rep. 1874, **13**, II, 111, 1875, **14**, I, 122. A. Jackel, Kunst. 1912, **2**, 407. A. Klem, Zts. ang. Chem. 1907, **20**, 610. Laborde and Lorifer, Erfind. Erfahr. 1903, **30**, 448. S. Mackie and C. Faure, Wag. Jahr. 1874, **20**, 424. G. Magnus & Co., D. R. P. 8273, 1878, Dingl. Poly. 1880, **235**, 668, Wag. Jahr. 1880, **26**, 835. W. Mam and A. Chaplet, Rev. gen. Sci. 1912, **23**, 102, Rev. gen. chim. 1912, **15**, 153; 1915, **18**, 73, C. A. 1912, **6**, 1072, 2168, 1915, **9**, 1831. B. Margosches, Chem. Centr. 1906, **77**, I, 1915. T. Martensen, Dingl. Poly. 1880, **235**, 203, 205. W. Mayer, Pharm. Centralh. 1899, **40**, 63. Goulier, Les Mondes, 1881, **55**, 191. M. Mur, Nature, 1881, **22**, 370. A. Parkes, Chem. News, 1880, **42**, 59. H. Parkes, 1880, **26**, 835. D. R. P. 10210, Wag. Jahr. 1880, **26**, 835. J. Paul, Phot. Corr. 1898, **35**, 221. F. Plate, L'Industria, 1915, **29**, 346, 364, 380, C. A. 1916, **10**, 906. U. De La Royné, Prac. Eng. 1892, **6**, 41, Sci. Amer. Suppl. 1891, **32**, 13062. Sadtler, Inv. 1886, **1**, 570, Sci. Amer. 1887, **56**, 69. Celluloid-Fabrik Schremer & Sievers, D. R. P. 71204, Chem. Tech. Rep. 1893, **32**, II, 163. R. Schupphaus, J. Ind. Eng. Chem. 1915, **7**, 290, C. A. 1915, **9**, 1390. H. Schwarz, Zts. ang. Chem. 1913, **26**, I, 32. Stebbing, Bull. Soc. Franc. Phot. 1881, **27**, 177. E. Stich, Kunst. 1911, **1**, 441. Celluloid, 1907, **7**, 107. Telschow, Vertelj. Schr. Zahnk. 1882, **2**, 336. F. Tribouillet and L. deBeuncke, D. R. P. 6828; Dingl. Poly. 1880, **235**, 203; Wag. Jahr. 1879, **25**, 111. L. Turin, Le Geme Civil, 1904, **44**, I, 152, 170, 190. M. Vincent, Proc. U. S. Nav. Inst. 1881, **7**, 350. Mem. Soc. Ing. Civils, July, 1881; Ann. Ind. 1881, **1**, 687; Rev. Ind. 1881, **12**, 214; Gen. Civ. 1881, **1**, 354, Technol. 1881, **43**, 84, Mon. Ind. Belg. 1881, **8**, 153; Design. 1881, **10**,

by means of alcohol, and the transformation of this celluloid gel into the finished product by heat and pressure. The pyroxylum

471. Voight, Bayer Ind. Gewer. 1899, **31**, 185; Zts. Dent. Ing. 1899, **43**, 524; Gummi Ztg. 1899, **13**, 620; Gewerb. Ztg. 1899, **64**, 283; Zts. Bursten, 1899, **19**, 25; Eisind, 1899, **20**, 680. C. Weygang, E. P. 111171, 1916; J. S. C. I. 1918, **37**, 14-A. W. Will, Zts. ang. Chem. 1906, **19**, 1377; Wag. Jahr. 1906, **52**, II, 529. W. Whitney and J. Ober, J. A. C. S. 1901, **23**, 856. G. Utz, Die Celluloid Ind. 1912, **12**, 73. Anon., Mon. Sci. 1880, **22**, 696. Wag. Jahr. 1878, **24**, 294, 1162; Dmgl. Poly. 1878, **229**, 541; Verhandl. Foerder. Gewerbeffleiss, 1878, Indbl. 1878, 117; Dent. Ind. Ztg. 1878, 127; Chem. Centr. 1878, **49**, 831; Wuerttemberg. Bewerbl. 1878, 203. Ind. Ztg. 1881, **22**, 56; J. Buchdr. 1884, **51**, 453; Must. Ztg. 1881, **30**, 71. Bayer Ind. Gewerbl. 1880, **12**, 457, 1886, **18**, 327, 1908, **40**, 59. Hon. Techn. Centr. Anzeiger, 1886, 35. Pharm. Era, 1911, **44**, 243. Mon. Phot. 1902, **9**, 229. Gummi. Ztg. Celluloid Suppl. 1908, **33**, Dec. 4, 18. Jan. 8, 22, 1909. Paper, 1893, **26**, No. 25. Sci. Amer. 1892, **66**, 261. Oil, Paint, Drug. Rept. Aug. 12, 1912, J. S. C. I. 1912, **31**, 847. Board Trade J. Dec. 5, 1912, J. S. C. I. 1912, **31**, 1204. Dmgl. Poly. 1885, **256**, 282; Indbl. 1885, 206; Chem. Tech. Rep. 1885, **24**, I, 93. La Nature, 1873, **1**, 383. Sci. Amer. Suppl. 1902, **21**, 809. U. S. Cons. Reports, May 20, 1902, J. S. C. I. 1902, **21**, 800. Kunst. 1911, **1**, 36, 97, 261, 320, 1912, **2**, 178, 300, 1914, **4**, 138, 1915, **5**, 23, 85. Amat. Photo. 1889, **10**, 57, 232, 1891, **14**, Q. 306, 365, A. 327, 423, 1891, **20**, OV. 91, 1896, **23**, 382, 1897, **26**, 291, 364, 1898, **28**, 616, 889, 1901, **40**, NC. 381. Neue Erfind. Erfahr. 1874, **1**, 465, 1879, **6**, 505, 1880, **7**, 457, 458, 510, 511, 512, 557, 558, 1881, **8**, 91, 632, 1892, **19**, 297, 1899, **26**, 230, 1906, **33**, 346, 1908, **35**, 381, 1909, **36**, 49, 97, 287, 1910, **37**, 91, 383, 1913, **40**, 280, 567. Jahr. Phot. 1893, **7**, 526, 1897, **11**, 500, 1899, **13**, 511, 1901, **15**, 273, 1903, **17**, 478, 179, 1907, **21**, 195, 1910, **24**, 636. Photography, 1890, **2**, 350, 1892, **4**, 282, 398, 114, 175, 1893, **5**, 791, 807, 1894, **6**, 425, 1896, **8**, 32, 47, 1902, **14**, 628, 1904, **18**, 61, 410. Gewerbl. Wurt. 1900, **52**, 299, 1903, **55**, 181. Photographic Review of Reviews, 1892, **1**, 180, 1893, **2**, 62, 278. Chem. News, 1881, **44**, 94, 106. Process. Photogram, 1889, **6**, 313, 1905, **12**, 163. Mon. Phot. 1891, **20**, 107, 130, 1902, II, **9**, 229. Photographische Industrie, 1912, 1178. J. Soc. Arts, **54**, 940. Photo. Chronical, 1901, **1**, 90. Cosmos, 1908, **58**, 222. Photographic Work, 1894, **5**, **3**, **4**, 182. G. Pratt, U. S. P. 743031. E. Thomson and J. Callan, U. S. P. 695127 and Re. 11997. E. P. 2264, 1902. K. Jung, U. S. P. 662444. E. P. 5755, 1900. D. R. P. 106446. Geo. Stevens, U. S. P. 650431 and Re. 11917. C. Stemmetz, U. S. P. 669358. E. P. 21293, 1900. A. Luck and C. Cross, U. S. P. 670346. E. P. 5286, 1898. Hung. P. July 13, 1898. Aust. P. July 9, 1898. D. R. P. July 7, 1898. J. Jarvis, U. S. P. 342208. P. Sweney, U. S. P. 184481. J. Lee, U. S. P. 767900. A. Schmidt, U. S. P. 758335. E. P. 25434, 1899. C. Jung and A. Kittel, U. S. P. 712997. J. Stevens and C. Thurber, U. S. P. 713169. E. Kempshall, U. S. P. 700125. I. Kitsee, U. S. P. 703135. A. LeRoy, U. S. P. 370546. F. P. 177524. Belg. P. 74802. Ital. P. Sept. 30, 1896. Aust. Hung. P. Nov. 4, 1886. Span. P. Nov. 13, 1886. H. d'Arnould, U. S. P. 682899. E. P. 391522. W. Clark and G. Rupley, U. S. P. 687517, 752592. E. P. 17842, 1905. J. de Long, U. S. P. 687131. G. Olmuhle, U. S. P. 931634. D. R. P. 178308. E. P. 366126. E. P. 6924, 1906. Swiss P. 35911. L. Grognot, U. S. P. 906219, 801436. H. Lebach, U. S. P. 965823. Aust. P. 45474. D. R. P. 214194 and Addn. 222534. Swiss P. 45913. E. P. 27096, 1908. S. Penney, U. S. P. 835113. J. Stockhausen, U. S. P. 1061881. E. P. 9264, 23630, 1911. Aust. P. 57422, 57428. Swiss P. 56153. F. P. 428468. M. Callahan, U. S. P. 1091628, 1091627. E. P. 24060, 24059, 1913. L. Streeter, U. S. P. 89254, 1869. L. Backeland, U. S. P. 942852, 942808. Swiss P. 54511, 45529. D. R. P. 223714. Aust. P. 52291. F. P. 389627, and Addn. 11628.

plastic art is an exceedingly ramified, imitative and highly developed industry, the products possessing properties superior to those of the originals which they are designed to simulate.

In 1856¹ and the following year² P. Bérard, and in 1859, S. Barnwell and A. Rollason³ in England, experimented with the "explosive cotton wool" patented there a few years previously by C. F. Schönbein,⁴ but it remained for Alexander Parkes to lay the foundation for our modern celluloid industry, which he

C. Schraube and E. Laudien, U. S. P. 892899. D. R. P. 180126. Farb. vorm. F. Bayer & Co., U. S. P. 924449. E. P. 26317, 1907. F. P. 384425. Aust. P. 38663. D. R. P. 201261. Swiss P. 40639. W. Cordner, U. S. P. 654951-2. E. P. 13846, 1899. E. P. 20934, 1899. Aust. P. 3051. Z. Olsson, E. P. 26935, 1911. See also E. P. 20404, 1906. F. Lamplough, E. P. 25240, 1897. U. S. P. 618692. Ver. Glanzstoff Fabr. A.-G., D. R. P. 208472-3, 235134. Aust. P. 35275, 35269. F. P. 385083, 379935. Swiss P. 41554, 41108. E. P. 16495, 27707, 1907. A. Litzler, E. P. 16519, 1906. F. Kleinsteinuber, E. P. 14335, 1894. D. R. P. 84065, see also D. R. P. 87673. S. Diesser, D. R. P. 223071. C. Grist, D. R. P. 92086, 111291. Aust. P. 2331. E. Meyer-Zimmerli, Aust. P. 30367. D. R. P. 188546. Swiss P. 40535. Felten und Guilleaume-Lahmeyerwerke, E. P. 19263, 1908; see also E. P. 5647, 1894; 16248, 1895; 13973, 1900; 2264, 1902; 18251, 26456, 1903; 2066, 1906. W. Bost, E. P. 2903, 1910. H. Manissadjian, F. P. 414679. E. P. 8646, 1910; see W. Merckens and H. Manissadjian, F. P. 413657. Farb. vorm. F. Bayer & Co., E. P. 18193, 1909. F. P. 408370 and Addn. 12469. I. Schofield, E. P. 6764, 1905. C. Hagemann and F. Zimmermann, E. P. 11456, 1898. H. Clement, E. P. 10320, 1910. J. Lambert, E. P. 13475, 1905. A. Ryder, E. P. 13188, 1905. E. Mitchell, E. P. 9242, 1905. F. Quarmby, E. P. 4419, 1905. A. Grice, E. P. 3763, 1905. G. Brandt, E. P. 2895, 1905. C. Smith, E. P. 1851, 1905. J. Aylsworth, F. P. 436192, 1911. Soc. Petticolin, F. P. 361391. G. Convert, F. P. 421843. P. Prost & J. Girard, Belg. P. 239664. G. Koller, Belg. P. 243162. S. de Medveczky, D. R. P. 239733. E. P. 27283, 1910. G. Gerard, E. Garbin and C. Gerard, D. R. P. 189971; see also G. Gerard, D. R. P. 185190. Badische Anilin- und Soda-Fabrik, D. R. P. 176474. Aust. P. 32175. J. Basler & Co., Russ. P. 14862. D. R. P. 185808. K. Winkler, D. R. P. Anm. W-30564. O. Whitcomb, Can. P. 11073, 1880. L. Dobbins, Can. P. 12123, 1880. J. Najlar, Can. P. 14009, 1882. J. Varley, Can. P. 20726, 1884. F. Greening, O. Peck and T. Potts, Can. P. 30807, 1889. A. and S. de Pont, Can. P. 40592, 1892. C. Shaw, Can. P. 62187, 1899. E. Brown, Can. P. 66548, 1900. J. Hinde, Can. P. 77779, 1902. Manhattan Mfg. Co., Can. P. 79695, 79696, 1903. Chem. Fab. von Heyd n A.-G., Belg. P. 232475, 1911. A. Wohl, Belg. P. 232699, 1911. Comp. Française des Applications de la Cellulose, Belg. P. 237056, 1911. Dusseldorfer, Belg. P. 237160, 1911. Caoutchouc & Guttapercha Co., Belg. P. 237230, 1911. J. Hartogs, Belg. P. 237471, 1911. J. Geistdorger, Belg. P. 237872, 1911. A. Hart, Belg. P. 237894. S. Courtauld & Co. and S. Napper, Belg. P. 238869, 1911. D. Lance, Belg. P. 244303, 1911. E. P. 28684, 1911; 2354, 6268, 10228, 17069, 21458, 25857, 1912; 18105, 23662, 1913; 1223, 9081, 9270, 21002, 1914. See also Brit. J. Phot. 1911, **58**, 637.

1. E. P. 607, 1856.
2. E. P. 1883, 1884, 1857; 639, 1858.
3. E. P. 945, 1859; 2249, 1860. Chem. News, 1860, **1**, 81; Amer. J. Pharm. 1859, **32**, 236.
4. E. P. 11407, 1846. Patent taken out in the name of John Taylor.

did in disclosures made first in 1855,¹ and succeeding years.³ While it is true that he made a distinct commercial failure, his Parkesine was the first meritorious attempt at the exploitation of what we now designate as the thermoplastic cellulose esters.³ His ideas were vague and nebulous, and his attempts to induce plasticity with vegetable oils futile, but unwittingly or otherwise, he laid down generalizations in his patent descriptions which furnished the nucleus around which this art has grown, and was the pioneer in the recognition of the usefulness of camphor in pyroxylin mixtures. M. Cartwright,⁴ T. Forster,⁵ and especially J. Lewthwaite,⁶ endeavored to extend the uses of Parkesine, but it appears with but little success. The endeavors of W. Thistlewaite,⁷ M. Mennons,⁸ M. Henry,⁹ J. MacIntosh and G. Rhodes,¹⁰ were apparently equally unfruitful, and all antedated the work of D. Spill. Up to this time no one appreciated the significance of the solvent power of camphor.

Daniel Spill, of Hackney, England, had been employed with Parkes, and he thought he saw wherein Parkes had failed to succeed. He endeavored to restore the prestige to this industry, but like Parkes, was hampered by too few known suitable sol-

1. E. P. 2359, 1855. For an account of the life of Alexander Parkes see Engineering, 1890, 111, Mining J. 1890, 855.

2. E. P. 1123, 1125, 1856; 2675, 1864; 1313, 2733, 3163, 1865, 1564, 1592, 2709, 1866; 865, 1695, 1867; 1366, 1614, 1868, 983, 1881. F. P. 69356, 1865; 71871, 76215, 1865, 144257, 1881. Belg. P. 55383, 1881. See H. Parkes, D. R. P. 10210, 1879, abstr. Dingl. Poly. 1880, **238**, 262; Jahr. Chem. 1880, **33**, 1369; Chem. Ztg. 1880, **4**, 584; Wag. Jahr. 1880, **26**, 835. U. S. P. 265337, E. P. 1865, 1879; F. P. 132495, 1879, Belg. P. 56230, 1881. He used a solution of camphor in carbon tetrachloride, carbon bisulfide, or sulfurous acid, aided by heat and pressure. See also Brit. J. Phot. 1865, **12**, 488.

3. E. Hornig, N. J. Pharm. **49**, 217; abstr. Chem. Tech. Rep. 1869, **8**, 1, 63. A. Parkes, Chem. News, 1862, **6**, 75. Builder 1863, 103. Deut. Indztg. 1864, 15; abstr. Poly. Centr. 1866, **32**, 554; Chem. Tech. Rep. 1865, **4**, II, 44; Wag. Jahr. 1865, **11**, 693. J. Soc. Arts, 1865, **14**, 81. Lond. J. Sci. **22**, 269. Chem. News, 1880, **42**, 59. Tech. Bl. 1880, **12**, 173. Chem. Tech. Rep. 1880, **19**, I, 179. Anon. Further Gewerbeztg. 1868, 79; abstr. Poly. Centr. 1869, **35**, 207. Engng. **5**, 65. Deut. Indztg. 1868, No. 44; Deut. Gewerbeztg. 1869, No. 1; Poly. Centr. 1869, **35**, 207, Chem. Tech. Mitth. 1868-69, 179. Sci. Amer. Suppl. 1880, 367, 3617.

4. E. P. 365, 1863.

5. E. P. 1222, 1868.

6. E. P. 741, 1868; 1433, 1882.

7. E. P. 1159, 1856.

8. E. P. 2775, 1860.

9. E. P. 1454, 1860.

10. E. P. 734, 1859. They nitrated "sawdust of white pine" to produce waterproofing compositions.

vents. Parkes was obliged to suspend operations in 1867. The next year Spill was granted his first patent for a pyroxylin compound dissolved in alcohol and ether, to which was given the name "xylonite."¹ Other patents² followed at frequent intervals up to 1875, the result being the incorporation of the British Xylonite Co., Ltd., June 13, 1877, when it took over the business of D. Spill & Co. The Homerton Manufacturing Co., Ltd., was established this same year, but in 1879 was amalgamated with the British Xylonite Co., and lost its identity.

Spill came over to the United States and founded the American Zylonite Co., whose product was known as "zylonite," and then sued the Celluloid Co. for using camphor and alcohol. Spill lost,³ for the courts decided that Parkes and not Spill was the original discoverer of the use of camphor and alcohol as a nitro-cellulose solvent.⁴

In the United States, J. Cutting, of Boston, in 1854⁵ and 1861,⁶ and G. Ray, in 1865,⁷ disclosed novel methods for the application of nitrocellulose, but especially W. Pierson, of New Orleans, in 1867,⁸ described a "plastic to be employed for manufacturing purposes generally," which covered about the same ground as Parkes, but Pierson showed a clearer concept of the particular nitrocelluloses applicable for a given result. Pierson was shrewd in that he kept away from castor oil—the stumbling block of Parkes and Spill. He worked so assiduously on the

1. E. P. 1739, 1875.

2. E. P. 1816, 2666, 1867, 3984, 1868, 3102, 1869, 180, 787, 1017, 1626, 2649, 1870, 1730, 1875. U. S. P. 91377, 91378, 97454, 1869, 101175, 1870, E. P. 85569, 1869, 88898, 1870. E. P. 2649, 1870 was taken out jointly with W. Henley. See D. Spill, *Wag. Jahr* 1877, **23**, 384.

3. D. Spill vs. Celluloid Manufacturing Co., U. S. Circuit Court, Southern District, N. Y., May 25, 1880, U. S. P. 97454, 101175. Decided Nov. 7, 1884, U. S. P. 89582, 156352. Mar. 4, 1886, U. S. P. 156353. Apr. 17, 1886, U. S. P. granted Apr. 17, 1870. July 27, 1886, U. S. Pat. Gaz. 1886, **36**, 1043.

4. For additional data on xylonite, see Bayer *Ind. Gewerbebl.* 1871, **3**, 309, *Year Book Pharm.* 1871, 219, *Pharm. J.* (3), **1**, 555, J. Buchdr. 1887, **54**, 870, *Eisen Zts.* **8**, 664, *Zts. Pap.* **1**, 724, *Iron Age*, **39**, No. 11; *Chem. Tech. Rep.* 1871, **10**, II, 69, S. Corbeels (E. P. 2312, 1877) made combs of xyloidine or xylonite. Xylonite (cotton xyloidine, xyloinite) should not be confounded with xylonith (*Chem. Tech. Rep.* 1871, **10**, II, 69) or xyloolith (A. Frass, E. P. 427546, 1911, abst. *J. S. C. I.* 1911, **30**, 1118). See also *Phot. News*, 1870, **14**, 608, *Brit. J. Phot.* 1870, **17**, 599, 603.

5. E. P. 1638, 1854.

6. U. S. P. 31657, 1861.

7. U. S. P. 48239, 1865.

8. U. S. P. 65267, 1867.

problem as to result in a nervous breakdown, and ere he had recovered the problem had slipped from him and was in other hands.

The general trend of research along this line at this time was in endeavors to fabricate a successful dental plate without the use of rubber. They all found in working with castor oil (seeking to impart permanent plasticity) that it would "fry out" and come to the surface. C. Seeley¹ found nitroglucose to be an excellent high boiling solvent, but no one wanted to experiment with this explosive body. J. McClelland² and L. Streeter,³ both dentists, but working independently, used solvents, but only atmospheric pressure. J. Kendall and R. Trested⁴ laid down generalizations which hold good to-day. All seemed to fall into the error of regarding castor oil as a solvent, and working harmoniously with pyroxylin, whereas we know that it is a direct precipitant and antagonist.

In 1863, Phelan & Collender, billiard ball manufacturers of New York City, offered a prize of ten thousand dollars—a magnificent sum in those days—for the patent rights of a process of manufacturing ivory billiard balls without the use of solid ivory, and as John W. Hyatt, then a printer in Albany, New York, had acquired some experience in this field as the result of previous patents granted to him,⁵ he set about in earnest to attempt to win that prize. In common with other printers who handled type continually, the sharp points of the type often

1. U. S. P. 79261, 1868, J. Soc. Arts, **19**, 390. H. Little (E. P. 24955, 1902) patented the use of nitroglycerol for the same purpose.

2. U. S. P. 90765, 90766, 1869, E. P. 536, 1868, in which in endeavoring to make dental plates, he seeks to overcome the tendency to blister by the application of heat in the presence of low boiling point solvents by the addition of castor oil, and in U. S. P. 76221, 77304, 1868 (Reissue 3777, 3778, 1869) he endeavors to supplant the castor oil used by the English by means of a vacuum. Whereas McClelland endeavored to get collophon to a hard, horny state by a vacuum, Hyatt succeeded in the opposite direction by great pressure. The dependence placed upon castor oil is clearly shown up Spill's U. S. P. 97454, in which he tries many new solvents, but does not reduce the amount of castor oil present. In U. S. P. 96132, 1869, McClelland first speaks of "plasticity" as a property of collophon. Also U. S. P. 105823, 1870; 143772, 1873, E. P. 86144, 86546, 1869.

3. U. S. P. 88228, 88260, 89253, 89254, 1869. He obtained a fugitive plasticity by distending the pyroxylin by immersion in alcohol, the yielding, distensible, compressible and incompressible qualities evaporating with the alcohol.

4. U. S. P. 86841, 1869.

5. U. S. P. 31461, 1861, 35652, 1862, 50359, 1865, 76765, 1868, 88633, 88634, 89582, 91233, 91234, 91235, 1869.

abraded the finger tips, and it was customary to protect them by applying a little "liquid cuticle," this being the name in the trade at that time for pharmaceutical collodion. One day, upon going to the cupboard for some "cuticle," the vial was found to have been upset, the contents having run out on the shelf and solidified, but due to the volatile nature of the then known solvents, had pulled itself away from the wood, forming a transparent, colorless pellicle. The thought occurred to Hyatt that here was a material which possibly might be made to envelop a matrix or filler of some kind and thus produce an acceptable billiard ball. This incident turned him to experimentation with pyroxylin, which was in the fall of 1868. At that time, and until obliged to modify his U. S. P. 91341 of 1869, he was unaware that any prior art existed in this field along these lines. Joined in 1869 by his brother Isaiah, at that time an editor at Rockford, Ill., a systematic series of experiments was undertaken, in which all the then known solvents and solvent combinations were tried but always aided by pressure. Hyatt's earlier patents taught him the value of pressure as an adjunct to increasing solubility, either with or without the simultaneous application of heat.¹

He found that great pressure and heat aided solution, but until camphor was tried a non-moldable, non-thermoplastic compound always resulted. His predecessors had all used large quantities of castor oil to impart plasticity. Hyatt used none.

1. J. Hyatt, U. S. P. 138254, 1873; abst. Amer. Chemist, 1873, **4**, 79. 204227, 1878. 296967, 1884; abst. Chem. Tech. Rep. 1884, **23**, 1, 107; Chem. Ztg. 1884, **8**, 696. U. S. P. 331241, 331242, 331713, 1885. E. P. 3864, 1881. F. P. 96768; abst. Bull. Soc. Chim. 1874, **21**, 287; Ber. 1874, **7**, 1028; Wag. Jahr. 1874, **20**, 424. D. R. P. 3392, 1878; abst. Chem. Ind. 1878, **1**, 384; Dingl. Poly. 1879, **232**, 520. D. R. P. 6902, 1878; abst. Chem. Ind. 1878, **1**, 253. J. Hyatt and C. Burroughs, U. S. P. 204229, 1878. J. Hyatt and J. Everding, U. S. P. 326119, 1885. J. W. and I. S. Hyatt, U. S. P. 105338, 1870 and Re. 5928, 1874; 10469, 10546, 1884. U. S. P. 133229, 1872; 152232, 156353, 1874. E. P. 2101, 1870; 3101, 1872. F. P. 90752, 1870. I. Hyatt, U. S. P. 275215, 1883. D. R. P. 7104, 1878. Celluloid Co., E. P. 878, 1878. Anon., Ver. u. Mitth. des nieder-österr. Gewerbe. Ver. 1870, 13; abst. Poly. Centr. 1870, **36**, 857. Hahn. Wochenblatt für Handel und Gewerbe. 1879, 309; Wieck's Gewerbeztg. **44**, 237. Bayer. Ind. und Gewerbebl. 1879, **11**, 449; Sci. Amer. Suppl. **41**, 243. Gewerbebl. Württ. 1891, **43**, 332. Phot. Rev. of Rev. 1892, **1**, 239. Uhland's W. 1899 (1), **13**, 311. J. Clouet, Bull. Soc. Rouen. 1877, 36; abst. Dingl. Poly. 1877, **226**, 646. C. Hofmann, Pap. Ztg. 1877, 305; abst. Dingl. Poly. 1877, **224**, 661. Hyatt Brothers, Dingl. Poly. 1877, **224**, 341, 661; abst. Jahr. Chem. 1877, 1223; Pap. Ztg. 1877, 462; Dingl. Poly. 1877, **225**, 520; **226**, 646. Maschinenb. 1877, 296. Kunst. 1914, **4**, 177. Newark (New Jersey) Sunday Call, Feb. 7, 1919. Phot. News, 1875, **19**, 342.

Instead of nitrobenzene and other high-boilers as adjunct dissolving menstrua, he used relatively small amounts of low-boilers (alcohol and ether) with camphor, depending upon the combination of great heat and pressure as ancillary nitrocellulose solvents.¹

Hyatt made celluloid an economic success, and as the result of his initial efforts, aided by his co-workers and extended by a myriad of subsequent inventors, the pyroxylin plastics constitute to-day one of the most important peace-time cellulose nitrate industries. The question as to whether Hyatt, in fact, was the real inventor has been discussed exhaustively by v. Kerkhoff,² E. Worden,³ R. Schüpphaus,⁴ C. Chandler,⁵ L. Baekeland,⁶ C.

1 The exorbitant prices charged for rubber plates caused acute tension between the dentists of the land and the rubber manufacturers, and the former welcomed and tested gladly any product that appeared to offer relief from the use of vulcanized rubber. No doubt attempts of the dentists of the country to shake off the rubber trust spurred on investigators and in this manner contributed in no small measure to the success of the early days of celluloid.

In U. S. P. 105338, the Hyatts abandoned all liquid solvents, and started at the solid end of the problem, being in this respect just the opposite from the English inventors. Being practical men and realizing the cost and disadvantages of the large bulk of liquids, and having no preconceived ideas from familiarity with the literature of the subject, the mechanical experience of J. W. Hyatt was brought into use and this led to the discovery that camphor at its melting point under pressure is a direct and energetic cellulose nitrate solvent. While camphor melts at 175° it liquefies considerably under this temperature when subjected to great pressure. The Hyatts made pressure do what others tried to accomplish with solvents, and their success lay in keeping the ratio of solvent to pyroxylin low. Whereas others dissolved pyroxylin in solvents, Hyatts did the reverse and dissolved the solvents (camphor and alcohol) in pyroxylin.

For development of the pyroxylin plastic industry in Italy, see V. Ravizza, *L'industria Chimica*, 1908, **7**, 25-32, where an estimate of the first cost and maintenance expense is given for a plant having a capacity of 800 k. of celluloid per day. For Japanese celluloid industry, see *Chamber of Comm. Jour.*, Sept., 1910.

He commenced the manufacture of composition billiard balls with Osborn, Newcomb & Co. of Albany in 1863. In 1868, when experiments with pyroxylin-coated balls had given evidence of success, the Hyatt Manufacturing Co. was formed, which later was changed to the Albany Billiard Ball Co., the latter being in existence at the present time. The Newark, N. J., *Sunday News*, August 20, 1903, contains a five-column illustrated article on Celluloid written by J. H. Stevens. See also "The Celluloid Industries. Celluloid. Some Information Concerning Its Manufacture." 84 pages, 12mo. Newark, N. J., 1885.

U. S. P. 91341, Hyatt, and U. S. P. 91377, Spill, were both granted June 15, 1869; "Celluloid" as a trade mark was registered in the U. S. Patent Office Jan. 14, 1873, as No. 1102, and in 1883, and embraces every article manufactured by the Celluloid Co., even preparations of a liquid character.

2. *Zts. ang. Chem.* 1914, **27**, 383; *abst. Kunst.* 1914, **4**, 292.

3. *J. Ind. Eng. Chem.* 1911, **3**, 436; *abst. Kunst.* 1911, **1**, 293.

4. *J. Ind. Eng. Chem.* 1914, **6**, 440; 1915, **7**, 290; *abst. C. A.* 1914, **8**,

Joyce,¹ and F. Vanderpoel,² and there is no question but what the honor should go to him. On Jan. 23, 1914, he was awarded in New York the Perkin Medal as "The Inventor of Celluloid" in the broad sense that the pyroxylin plastics made throughout the world at the present time are substantially the processes inaugurated as the result of his ingenuity and perseverance.^{3,4}

L. Brown opened negotiations with the firm of D. Spill & Co., the result being the erection of a small factory at Adams, Mass., in 1881-82. The firm was known as the American Zylonite Co.⁵ and was under the technical leadership of G. Mowbray⁶

2250; 1915, **9**, 1390, Kunst 1914, **4**, 383, Mon Phot 1881, **20**, 74

5 J. Ind. Eng. Chem. 1914, **6**, 601, J. S. C. I. 1914, **33**, 677; abst. C. A. 1914, **8**, 2944

6 J. Ind. Eng. Chem. 1914, **6**, 90; abst. C. A. 1914, **8**, 1203

1 J. Ind. Eng. Chem. 1911, **3**, 702

2 J. Ind. Eng. Chem. 1914, **6**, 161; abst. C. A. 1914, **8**, 1203

3 J. S. C. I. 1914, **33**, 225; J. Ind. Eng. Chem. 1914, **6**, 155; Met. Chem. Eng. 1914, **12**, 131, C. A. 1914, **8**, 1203; Kunst. 1914, **4**, 171, 275. See also Dingl. Poly. 1877, **224**, 341. Der Techniker, 1880, 74, abst. Poly. Notiz. 1880, **35**, 53, Chem. Centr. 1880, **51**, 334. Poly. Notiz. 1879, **34**, 249, 297. For account of "camphorless" celluloid see Newark (N. J.) News, April 23, 1920, p. 4.

4 Those interested in the legal aspects of the litigation establishing the validity of the Hyatt patents should consult 85 Federal Reporter 449, 97 Fed. Rep. 91; 68 F. R. 428, 23 F. R. 397; 24 F. R. 275; 24 F. R. 585, 25 F. R. 319, 482; 30 F. R. 437; 35 F. R. 418; 28 F. R. 195; 68 F. R. 915, 31 F. R. 904; 34 F. R. 324; 44 F. R. 81, 52 F. R. 740, 42 F. R. 159, 37 F. R. 676, 85 F. R. 449, 97 F. R. 91; 36 F. R. 110, 27 F. R. 291, 2 F. R. 707, 10 F. R. 290, 21 F. R. 631; 22 F. R. 94. Federal Cases, 2543. U. S. Pat. Gaz. 1883, **23**, 1121, U. S. P. 99032 held invalid. U. S. Pat. Gaz. 1886, **36**, 1356. Phot. News, 1890, **34**, 224.

5 U. S. P. 91377, 91378, 97454, 1869, 101175, 1870, 97454 fairly represents the extent of information which the public or anyone else possessed at that time on the question of pyroxylin solvents. The discovery that camphor was a solvent of pyroxylin without the admixture of a liquid, although chemically important, was not practically available in the art by reason of the danger of explosion of the pyroxylin when the compound was heated to its melting point. His most important American patent is 101175, in which cotton or other vegetable fiber or lignine is reduced to a finely divided state, mixed with the aid of mechanical means in a vessel having revolving arms or beating bars, with a suitable quantity of acid; the acid strained from the fiber, the product pressed to remove excess of acid, and the pressed mass then opened out, washed, drained, and dried. The xyloidine is bleached directly after the removal of the acids and before removing it from the vat by means of any bleaching solution, making use of alternate stirrings and rest. It is dyed after draining and before pressing, by any fiber-dyeing process, either before or after the solution of the same in suitable solvents. For spreading upon fabrics 1 part of xyloidine is dissolved in from 5 to 12 parts of solvent, strained through a fine sieve under pressure, and spread on the fabric or surface in a semi-fluid condition. To reduce it to a nearly dry state the strained solution or paste is treated in a closed mixing vessel connected with an exhaust apparatus, the vessel being heated to about 100°. The

and J. Edison,¹ and R. Schupphaus.² The firm was absorbed by the Celluloid Co. in 1890.

About 1878, J. France, of Plainfield, N. J., started work on nitrocellulose, his first patent being granted in 1888.³ In 1881, C. Kanouse⁴ assigned to A. Thalheimer, of Newark, N. J., his pyroxylin patent. Thalheimer worked the Kanouse patent under the name of "The Merchants Manufacturing Co." and the product was called "Pasbosene." In 1883, this company united with France to form the "Cellonite Co.," the name of the material being changed to cellonite. In 1885 the factory removed to Arlington, N. J., and the name changed to "pyralin." Later this plant was acquired by E. I. du Pont de Nemours Co. Pasbosene, cellonite, and pyralin, are names for pyroxylin plastics similar to celluloid.

V. Smith, of Schenectady, N. Y., was granted a patent in England in 1875⁵ for a pyroxylin plastic, this product being manufactured in the United States. The first material was used in imitation of jewelry, and called "Coralline." The Lignoid Fancy Article Manufacturing Co., once located in Newark, N. J., and afterwards removed to Newburyport, were the predecessors of the present Fiberloid Co. Their product was known as Lignoid and afterwards Fiberloid. Daniel and David McCaine, of St. Paul, Minn., made billiard balls and other solid products, their product being known as Fiberoid. The Viscoloid Co., of Leominster, Mass., are also pyroxylin plastic artificers. L. Deitz and B. Wayne,⁶ J. and C. Schmerber,⁷ S.

solvent vapors that pass off are condensed for reuse.

Spill came personally to the United States and sued the Celluloid Co. for using a mixture of camphor and grain alcohol and won. Celluloid Co. then used camphor and wood alcohol, and Spill sued again. At the second trial it was proven that Parkes, and not Spill, was the first to describe the use of camphor with alcohols, hence second suit was lost to Spill and first decision appealed and reversed. (Spill vs. Celluloid Mfg. Co., 22 Matchford C. C. R. 441.) Nixonoid is the product of Nixon Nitration Works.

6. U. S. P. 294661, 1884; abst. J. A. C. S. 1884, **6**, 145.

1. U. S. P. 356108, 1887.

2. See J. Ind. Eng. Chem. 1915, **7**, 290; abst. C. A. 1915, **9**, 1390 Cosmos, 1885, **2**, 382.

3. U. S. P. 392794.

4. U. S. P. 274734, 1881.

5. E. P. 2513, 1875. See T. and W. Nicholls, E. P. 2073, 1882.

6. U. S. P. 133969, 1872; abst. Amer. Chemist, 1872, **3**, 317.

7. U. S. P. 233558, 1880; abst. J. A. C. S. 1880, **2**, 403.

Hoggson and G. Pettis,¹ and J. McClelland,² did much toward formulating this art in its earlier days.

The first pyroxylin factory erected on the Continent was built in Stains, at St. Denis, in 1875, by the "Compagnie Franco-Americane," working the Hyatt patents. By an arrangement with this firm, Magnus & Co., of Berlin,³ took up the manufacture for a short while. The first German celluloid factory commenced operations in 1878 at Offenbach-on-the-Main, and is in operation at the present time under name of Schreiner & Sievers. At a later period, Dobler Bros., of Berlin, followed.⁴ There the processes of A. Vangel,⁵ and of C. Wolf⁶ were used in a comparatively small way. In 1880 the Rheinische Hartgummiwaarenfabrik in Mannheim was started. The Gummi- u. Zelluloid fabrik near Mannheim, in order to avoid possible danger from fire or explosion, nitrates and converts at Rhcinau, and prepares the finished articles at Neckarau, some twenty miles distant.⁷

In Japan the Sakai Celluloid Co.⁸ has erected a large modern plant. In Italy,⁹ at the present time, it would appear that considerable progress in manufacture is being made. The "pyroxyleine" produced in 1878 in France¹⁰ has expanded until at present¹¹

1. U. S. P. 245952, 1881.

2. U. S. P. 363197, 1887; abst. J. Amer. Chem. Soc. 1887, **9**, 158.

3. D. R. P. 8273; abst. Wag. Jahr. 1880, **26**, 835.

4. For development of celluloid in Germany see Kunst. 1911, **1**, 459, 480; 1912, **2**, 158, 159, 196, 257, 338; 1913, **3**, 20, 38, 59, 116, 296, 334, 357; 1914, **4**, 79, 257, 1915, **5**, 23, 71, 83. Caoutchouc & Gutta-p. 1915, **12**, 8604; abst. C. A. 1915, **9**, 1690. Mon. Sci. 1908, **68**, 648.

5. D. R. P. 7162.

6. D. R. P. 7860; abst. Wag. Jahr. 1879, **25**, 1154.

7. The development of celluloid in Germany may be shown by the following official trademarks. 475506, 475507, 476715, 478097, 484388, 484390, 504171, 518856, 518910, 519746, 540313, 552857, 559226, 577184, 577590, 579954, 584388, 584389, 588779, 588550, 604982; abst. Kunst. 1912, **2**, 359; 1913, **3**, 120, 220, 279; 1914, **4**, 20, 40, 120, 260; 1915, **5**, 71.

8. Chem. Drug. Aug. 29, 1909; abst. J. S. C. I. 1909, **28**, 958. Chamber of Comm. J. Sept. 1910. Board of Trade J., Aug. 3, 1911; abst. J. S. C. I. 1911, **30**, 1008; C. A. 1912, **6**, 930. J. Ind. Eng. Chem. 1911, **3**, 139. Board Trade Sept. 1911, abst. Rev. chim. ind. 1912, 244. Kunst. 1913, 221, 248, 438; 1914, **4**, 195. J. Axtell, J. Ind. Eng. Chem. 1913, **5**, 38; abst. C. A. 1913, **6**, 698. See J. S. C. I. 1920, **39**, 176-R for a review of the Japanese celluloid industry.

9. V. Ravizza, L'Industria Chimica, **7**, 25; abst. C. A. 1907, **1**, 1322.

10. Tribouillet and de Basancele, F. P. 126846, 1878; abst. Mon. Sci. 1879, **21**, 1032. Credit is due P. Bérard (F. P. 31315, 32264, 32790, 1857; 35368, 35827, 1858; 41098, 42511, 1859) for early work in this field, as also to G. Gerard (F. P. 44902, 1860) and V. Roger and J. Ledion (F. P. 38214, 1858; 42210, 1859).

11. Anon. Chem. Ind. 1910, **33**, 541.

- there are eight factories engaged in celluloid manufacture.

Pyroxylin Plastic Manufacture. A great many attempts have been made from time to time to enter the field of pyroxylin plastic manufacture, as is indicated by the following list of names. Argonite, Alberite,¹ Apiroid,² Boroid,³ Camphoid,⁴ Celluline,⁵ Cellulodine,⁶ Cellulosine,⁷ Crystalloid,⁸ Celluloid (Lithoxyle, Phibrolithoid),⁹ Dermatoid,¹⁰ Elastozon, Exonite,¹¹ Histoloid,¹² Hyaline,¹³ Ivorine,¹⁴ Ivoride,¹⁵ Parckut,¹⁶ Prostine,¹⁷ Pyroxyliid,¹⁸ Setoloid,¹⁹ Satolite,²⁰ Securite,²¹ Sternoid,²² Steroxylin,²³ Suberit,²⁴ Vegetalin,²⁵ Vitroloid,²⁶ Xylamile,²⁷ Xylinite,²⁸

1. Alberite is the name given to celluloid used as the handles of brushes set in hard rubber, and also known as rubberset.

2. P. Nogues and H. Proveux, F. P. 328054, 1902, abst. J. S. C. I. 1903, **21**, 1254.

3. Electrician 1910, **65**, 533.

4. Camphoid is obtained by dissolving 10 parts of nitrocellulose in 400 parts of a solution of camphor in absolute alcohol.

5. I. Pulvermacher, E. P. 3485, 1881.

6. U. Marga, E. P. 21470, 1895, abst. J. S. C. I. 1895, **14**, 1007; 1896, **15**, 763, 828.

7. F. Cadoret and E. Degraide, E. P. 21485, 1892, abst. J. S. C. I. 1893, **12**, 779; Chem. Tech. Rep. 1894, **33**, I, 141.

8. India Rubber World, Jan. 26 and Nov. 1, 1898.

9. C. Stocker, E. P. 16330, 1887. For "Cellulide," see A. Tavernier and C. Oulman, F. P. 413152, abst. J. S. C. I. 1910, **29**, 1095.

10. Dermatoid-Werke, Paul Meissner, Leipzig.

11. H. Dover, E. P. 9321, 1905.

12. Manufactured by Celluloid Co., Newark, N. J.

13. F. Eckstein, E. P. 14569, 1889, abst. J. S. C. I. 1890, **9**, 838, 954; 1889, **8**, 850.

14. Deutsche Roll Film Fabrik, Berlin.

15. E. P. 2312, 1877.

16. Les Mondes, 1869, **19**, 682; 1871, **26**, 371.

17. P. Prost, E. Michey and P. Cocholat, Belg. P. 176057, 181151.

18. E. P. 15349, 1895.

19. Phot. News, 1898, 40, abst. Jahr. Phot. und Reproduktionstechnik, 1899, 511, Bull. de Phot. Club de Paris, 1898, 181.

20. S. Satow, U. S. P. 245975, 1245976, 1245983, 1245984, 1275308, 1280861, 1280862, 1917, abst. J. S. C. I. 1918, **37**, 27A, 669A, 1919, **38**, 9A;

C. A. 1919, **13**, 73, 80. E. P. 121141, 1917; abst. J. S. C. I. 1919, **38**, 263A. Can. P. 191262, 191263, 1919; abst. C. A. 1919, **13**, 1928. J. Ind. Eng. Chem. 1917, **9**, 913. Sci. Amer. 1918, **118**, 191. Jap. P. 29247, 28307, 1917.

21. Peschard and Mestrallet, F. P. 298031, 1900, abst. Mon. Sci. 1901, **57**, 56.

22. Dickinson Mfg. Co., Springfield, Mass.

23. Gewerbl. 1863, 258; abst. Chem. Tech. Rep. 1863, **2**, II, 64.

24. E. P. 2143, 1902.

25. O. Streubel, E. P. 127, 1879; abst. Mon. Sci. 1880, 1879; J. A. C. S. 1880, **2**, 103.

26. Manufactured by Buffalo Transparent Products Co., Buffalo, N. Y.

27. As made by the Societe de Chromolithie, 1896.

28. Ann. Rept. H. M. Inspec. Explosives, 1882, 23, 24.

Xylonith,¹ and Xyloidine.² The Pegamoid of F. Annison³ and F. Oliver⁴ is a pyroxylin similar plastic. Pulverloid Marloid,⁵ and crystalloid Mestrine,⁶ Lactite,⁷ Pyrosa,⁸ Duranoid, Crystallate, Lactroid, Protol, Micaroid, Crinoid, Bonsilate, Kerite, Hevenoid and Volenite are names of plastics, the majority of which do not contain pyroxylin.

The general method of pyroxylin manufacture as described herein is based on the principles enunciated in the Hyatt⁹ patents. Variations from those basic ideas have, of course, been devised by many, among which may be mentioned L. Ach,¹⁰ A. Azemba-Bigon and C. Biliotti,¹¹ A. Bartels,¹² L. Beals,¹³ W. Beatty,¹⁴ W. Bonner,¹⁵ Dusseldorfer Celluloidfabrik Ges.,¹⁶ O. Eberhard,¹⁷ J.

1. M. Heeren, *Zts. Ver. d. Ing.* 1871, 149; abst. *Poly. Centr.* 1871, **36**, 789.

2. H. Stevens, *Paper and Pulp*, 1905, **10**, 656; abst. *J. S. C. I.* 1905, **24**, 1250.

3. U. S. P. 508497, 1893; Re. 11467, 1895; E. P. 19710, 1891; F. P. 223838, 1892, Belg. P. 101094, 1892; Can. P. 46932, 1894. Publishing, Advertising and Trading Syndicate, Can. P. 51149, 51695, 1896; 58321, 1897, 58793, 1898.

4. E. P. 11666, 17747, 1894; 10103, 10105, 1896; U. S. P. 578355, 1897; 601927, 602797, 1898. For additional information see *Farb. Ztg.* 1904, **40**, 159; S. Ferenczi, *Zts. ang. Chem.* 1899, 51; *Am. Apoth. Z.* 1899, **20**, 93. Bottler, "Practical Applications of Pegamoid," *Am. Apoth. Z.* 1899, **26**, 1. Lefevre, "Technical Applications of Pegamoid," *Mon. Text. Ind.* 1897, **12**, 677; "Pegamoiding," *Somme, Chem. Tech.* 1898, **16**, No. 24; "Applications of Pegamoid in the Textile Industries," *Ind. Text.* 1898, **14**, 91.

5. *Am. Apoth. Ztg.* 1900, **21**, 75. J. Fischer, *Gewerbebl. Wurt.* 1900, **52**, 347. In this connection see *Chem. Centr.* 1876, **47**, 576; *Bull. Soc. d'Enc. (3)*, **3**, 207. Martius, *Chem. Tech. Rep.* 1877, **16**, I, 288, 487. *Deut. Ind. Ztg.* **19**, 127. *Amat. Phot.* 1890, **12**, 259. *Wag. Jahr.* 1896, **42**, 1068. *Sci. Amer. Suppl.* 1905, No. 24462-3, 59; 1906, 25190-1, 61. E. P. 22528, 1907; 22236, 1908.

6. E. Mestrallet-Petry, F. P. 372018, 1906; W. Massot, *Zts. ang. Chem.* 1908, **21**, 340; *J. S. C. I.* 1907, **26**, 430.

7. G. Convert, F. P. 335694, 1903.

8. A. Blanchin, F. P. 364690, 1906; abst. *C. A.* 1907, **1**, 2959; *Chem. Zts.* 1906, **5**, 399.

9. J. Hyatt, J. Stevens and J. Everding, U. S. P. 296969, 296970, 1884; abst. *J. A. C. S.* 1884, **6**, 204.

10. D. R. P. 214962, abst. *J. S. C. I.* 1909, **28**, 1270. U. S. P. 996191.

11. F. P. 418009; abst. *Kunst.* 1911, **1**, 114.

12. E. P. 10049, 1915; *Swiss. P.* 72634; abst. *C. A.* 1917, **11**, 90. See also *C. A.* 1916, **10**, 2627.

13. U. S. P. 239423, 239424, 239425, 1881.

14. U. S. P. 1158961, 1915; abst. *C. A.* 1916, **10**, 275.

15. U. S. P. 1180902, 1916; abst. *C. A.* 1916, **10**, 1699.

16. E. P. 17069, 1912. Cf. D. R. P. Anm. D-25590, 1911; abst. *Chem. Ztg.* 1912, **36**, 765.

17. U. S. P. 1088555, abst. *J. S. C. I.* 1914, **33**, 343; F. P. 455959; abst. *J. S. C. I.* 1913, **32**, 933; E. P. 8003, 1913; abst. *J. S. C. I.* 1914, **33**, 541.

Edson,¹ G. Fretard,² G. Hagemann,³ M. Herve,⁴ Hogben,⁵ Internationale Cellulose-Ester Gesellschaft,⁶ Kammer and Reinhardt,⁷ T. Kelly,⁸ A. Klinger,⁹ G. Koller, J. Herbabny and O. Jolles,¹⁰ S. Halen,¹¹ O. Kausch,¹² L. Lilienfeld,¹³ A. Luft,¹⁴ G. Magnus & Co.,¹⁵ P. Marino,¹⁶ E. Muller,¹⁷ G. Pelmeur, W. Cummings and W. Meggeson,¹⁸ A. Oetker,¹⁹ S. Morimura,²⁰ C. Peterson,²¹ A. Rowe,²² R. Schupphaus,²³ Self Developing Plate Co. and T. Bolas,²⁴ Henley and Spill,²⁵ J. Stevens,²⁶ P. v. Weimarn,²⁷ Vuagnat and Gaget,²⁸ C. Wertheim,²⁹ and E. Zuhl.³⁰

In the typical manufacturing process, the nitrated cellulose (usually paper) may be bleached if to be used for transparent

- 1 U. S. P. 350049, 1886
- 2 F. P. 452579, 1912, abst. J. S. C. I. 1913, **32**, 667, C. A. 1913, **7**, 3674
- 3 E. P. 13838, 1894, abst. J. S. C. I. 1894, **13**, 866, 1895, **14**, 418
- 4 Mon. Sci. 1918, (5), **8**, II, 193, abst. Chem. Zentr. 1919, **90**, II, 297.
- 5 Gas Light, **57**, 77.
- 6 D. R. P. 239701, 1910, abst. Chem. Zentr. 1911, **82**, II, 1502
- 7 D. R. P. Ann. K-47321, 1911, Addn. to D. R. P. Ann. K-44709
- 8 E. P. 5712, 1911, abst. C. A. 1912, **6**, 2547.
- 9 Aust. P. 28236, 1906
- 10 D. R. P. Ann. K-46794, 1911.
- 11 S. Halen, Kunst. 1914, **4**, 365
- 12 O. Kausch, Kunst. 1911, **1**, 10, 86, 131
- 13 E. P. 15657, 1912, D. R. P. Ann. L-29406, 1910, Aust. Appl. July 18, 1911
- 14 U. S. P. 735278, 1903, abst. J. S. C. I. 1903, **22**, 1012, E. P. 10218, 1902, abst. Kunst. 1913, **3**, 302, J. S. C. I. 1902, **21**, 1085, F. P. 320694, 1902, abst. J. S. C. I. 1903, **22**, 152, Aust. P. 14037, D. R. P. 140552
- 15 D. R. P. 8273, abst. Wag. Jahr. 1880, **26**, 835, Dingl. Poly. 1880, **235**, 468.
- 16 Swiss. P. 48231, abst. Kunst. 1911, **1**, 73
- 17 E. P. 12867, 1898, abst. J. S. C. I. 1898, **17**, 627, 744, 756.
- 18 E. P. 12885, 1898, abst. J. S. C. I. 1898, **17**, 628, 1899, **18**, 728
- 19 E. P. 4663, 1913, abst. C. A. 1914, **8**, 2497, see also C. A. 1914, **8**, 435.
- 20 F. P. 409661, 1909, E. P. 27266, 1909, abst. J. S. C. I. 1910, **29**, 557.
- 21 U. S. P. 552697, 1896
- 22 E. P. 21708, 1912, abst. J. S. C. I. 1913, **32**, 1027.
- 23 Ber. 1895, **28**, 678, 1896, **29**, 452
- 24 E. P. 21880, 1907, abst. J. S. C. I. 1908, **27**, 1081.
- 25 F. P. 91387, 1870
- 26 U. S. P. 583517, 589870, 608726, 608727, 609475, 610596, 610615, 610953, 612531, 613400, 614514, 617450, 621433, 621434, 622290, 622291, 622292, 622293, 622294.
- 27 D. R. P. 275882; abst. C. A. 1915, **9**, 378
- 28 D. R. P. Ann. V-9371, 1910
- 29 Aust. P. 6007, 1899, Addn. to Aust. P. 3364.
- 30 U. S. P. 700885, 1902; abst. J. S. C. I. 1902, **21**, 870, E. P. 8072, 1901; abst. J. S. C. I. 1901, **20**, 741.

sheets,¹ after which it is pulped to a fine state of subdivision in order to insure uniform union with the camphor, which is also finely comminuted. Both are then intimately mixed by grinding, as in the processes of J. Hyatt,² and J. and C. Schmerber and J. Arrault,³ O. Chase,⁴ P. Claus,⁵ C. Lockwood,⁶ W. McCaine,⁷ H. Parkes,⁸ and L. Pillion.⁹ A stabilizer¹⁰ is next incorporated, as urea¹¹ or some of the other ant-acids as patented by J. Stevens,¹² C. Claessan,¹³ E. Rouxeville,¹⁴ R. Schüpphaus,¹⁵ and K. Voigt,¹⁶ and described in detail elsewhere herein. The pulp is next dehydrated, as according to the methods of J. Hyatt,¹⁷ I. and J. Hyatt,¹⁸ J. Edson,¹⁹ J. France,²⁰ G. Mowbray,²¹ and H. Werthein.²²

In the manufacture of pyroxylin plastics, the amount of solvent (usually alcohol) added to the nitrocellulose is comparatively small, and its recovery is seldom attempted. However, in some instances the methods of solvent regaining as of C. Claessen,²³

1. J. S. C. I. 1891, **10**, 571.
2. U. S. P. 331713, 1885.
3. U. S. P. 229477, 1880.
4. D. R. P. 25886, 1883.
5. E. P. 3072, 1882; abst. J. S. C. I. 1882, **1**, 201.
6. U. S. P. 246891, 1881; abst. J. A. C. S. 1881, **3**, 166.
7. U. S. P. 217232, 1879. See P. Pfeiderer, U. S. P. 534968, 1895.
8. Deut. Ind. Ztg. 1880, 410; abst. Poly. Notiz. 1880, **35**, 330.
9. D. R. P. 49764; abst. Bayer. Ind. und Gewerbebl. 1906, **38**, 193.
10. Photography 1901, **13**, 429; Amat. Phot. 1906, **44**, 482.
11. G. Hase, Photographisches J. 1855, **3**, 15.
12. U. S. P. 622293, 1899; 614514, 1898; 612531, 1898; 622291, 1899; 630945, 1899; 610566, 1898; 621433, 1898; 608726, 1898; 621434, 1899; 622290, 1899; 622294, 1899; 621382, 1898; 612067, 1898; 609475, 1898; 610953, 1898; 622292, 1899; 626732, 1899; 610615, 1898; 630944, 1899; 613400, 1898.
13. U. S. P. 617450, 1899; 589870, 1897; 608727, 1898; D. R. P. 178133, 1906.
14. F. P. 393310, 1908; abst. Mon. Sci. 1910, **73**, 134, 303.
15. U. S. P. 514838, 1894.
16. Zts. ang. Chem. 1906, **13**, 237; abst. Wag. Jahr. 1906, **52**, II, 530; Jahr. Chem. 1905-1908, 990. See also Bull. Soc. Franc. Phot. 1900, **16**, II, 504.
17. U. S. P. 200914, 1878; 265229, 1882; 296967, 296970, 297935, 1884; abst. J. A. C. S. 1884, **6**, 204. U. S. P. 180133, 1876. See also Celluloid Co., D. R. P. 263056; D. R. P. Anm. L-30181, L-30386, 1910.
18. U. S. P. 133229, 1872; abst. Chem. Ztg. Rep. 1912, **36**, 485.
19. U. S. P. 249600, 1881.
20. U. S. P. 393751, 393752, 1888; E. P. 17692, 1888.
21. U. S. P. 349659, 1886; abst. J. A. C. S. 1886, **8**, 238.
22. E. P. 6268, 1912; abst. Kunst. 1913, **3**, 314; C. A. 1913, **7**, 3025; J. S. C. I. 1913, **32**, 420. Aust. P. Anm. 1755, 1911.
23. D. R. P. 200595, 1917; abst. Chem. Zentr. 1917, **88**, II, 581.

E. Josephsen¹ and H. Schwarz² are applicable. After the moisture has been sufficiently expelled by pressure, the pyroxylin is converted into plastic³ by heat and pressure, by methods as previously indicated, and more specifically by the processes of J. Dixon,⁴ J. Kitsee,⁵ P. Leder,⁶ W. McCaine,⁷ A. Olszewski,⁸ Soc. A. Olier et Cie.,⁹ J. Stockhausen,¹⁰ W. Ludovici,¹¹ and H. Miller.¹² After completion of conversion by mastication, the "raw" plastic is dried or seasoned to remove the balance of volatile solvent, as according to the methods of E. Wiart,¹³ A. Olszewski,¹⁴ W. McCaine,¹⁵ W. Grosvenor,¹⁶ E. Deiss,¹⁷ and J. Edson.¹⁸ The seasoning as conducted by Farbenfabriken vorm. F. Bayer & Co.,¹⁹ E. Bronnert and T. Schlumberger,²⁰ O. Eberhard,²¹ J. Edson,²² J. Hyatt,²³ E. Thorn, G. Westondarp and C. Pieper,²⁴ E. Wiart,²⁵ and Convert,²⁶ finally results in a product which will not curl or wrinkle in moist air, and which may be fabricated into the finished articles of commerce. Denitration to reduce inflammability is not resorted to, although H. Turgard²⁷ and E. Weston²⁸

1. U. S. P. 1211588, 1917; abst. J. S. C. I. 1916, **35**, 288.
2. Kunst 1913, **3**, 421; abst. C. A. 1914, **8**, 421. Cf. J. Delpech, F. P. 441551, 1912.
3. U. Magra, D. R. P. 85235; abst. Wag. Jahr 1896, **42**, 1068.
4. U. S. P. 608512, 1898.
5. U. S. P. 900744, 1908; abst. J. S. C. I. 1908, **27**, 1220.
6. U. S. P. 974285, 1910; abst. C. A. 1911, **5**, 794.
7. U. S. P. 276443, 1883.
8. U. S. P. 280659, 1883.
9. E. P. 16606, 1911.
10. E. P. 9264, 23030, 1911; abst. C. A. 1913, **7**, 1299. D. R. P. 281262, 1910; Addn. to D. R. P. 277653; abst. C. A. 1915, **9**, 1136, 2008.
11. D. R. P. 170196, 1905.
12. U. S. P. 508112, 1893. See also Can. P. 20726, 1884.
13. E. P. 10198, 1913; abst. J. S. C. I. 1914, **33**, 594.
14. U. S. P. 280659, 1883.
15. U. S. P. 217232, 1879. Daniel and David McCaine, U. S. P. 286212, 1883.
16. U. S. P. 1143623; abst. C. A. 1915, **9**, 2313.
17. E. P. 5887, 1903.
18. U. S. P. 219235, 1879.
19. E. P. 17009, 1909; abst. J. S. C. I. 1910, **29**, 978.
20. E. P. 1858, 1896; abst. J. S. C. I. 1897, **16**, 355; 1900, **19**, 820.
21. U. S. P. 1088555, 1914; abst. J. S. C. I. 1914, **33**, 343, F. P. 455959, 1913; abst. J. S. C. I. 1913, **32**, 933.
22. U. S. P. 219235, 1879.
23. U. S. P. 254439, 1882.
24. Chem. Tech. Rep. 1891, **30**, II, 253. D. R. P. 58379, 1891.
25. E. P. 10198, 1913; abst. C. A. 1914, **8**, 3387.
26. F. P. 332021, 1903. O. Eberhard, F. P. 455995, 1913; abst. C. A. 1914, **8**, 2269. Cf. C. A. 1913, **7**, 2487.
27. U. S. P. 508124, 1893; F. P. 218759, 1892.
28. U. S. P. 264987, 1882.

have described methods for so doing. G. Benjamin has advocated the novel process of celluloid preparation by means of intense cold,¹ but his process has not been commercially established.

Many other methods² differing in essentials from that outlined above have been proposed from time to time, the original of which should be consulted for details. They include the methods of H. Miller,³ V. Tribouillet and L. Besancele,⁴ The Stains Company, L. Morane,⁵ L. Ach,⁶ L. Andes,⁷ Celluloid Fabrik Kirmeyer and Scherer,⁸ Baldauf Bros.,⁹ S. Barnwell and A. Rollason,¹⁰ J. Basler & Co.,¹¹ W. Beatty,¹² A. Behal,¹³ G. Benjamin,¹⁴ P. Berard,¹⁵ T. Best,¹⁶ F. Blyth and A. Suthby,¹⁷ F. Boeckmann,¹⁸ T. Bolas,¹⁹ P. Borrot,²⁰ and F. Borrot,²¹ J. Boyer,²² B.

- 1 U. S. P. 677012, 1901, abstr. *Mon. Sci.* 1901, **57**, 284.
- 2 *Chem. Tech. Rep.* 1878, **17**, 11, 106; *Chem. Centr.* 1878, **49**, 831; *Ind. Bl.* **15**, 392; *Pharm. Centrallh.* 1879, **21**, 195; *Poly. Notiz.* 1879, **34**, 249, 1880, **35**, 19, 1885, **40**, 306; *Ber.* 1885, **18**, 2228; *Chem. Tech. Rep.* 1879, **18**, 1, 146; *Dingl. Poly.* 1880, **235**, 203; *Neue. Erlin. und. Erfah.* 1879, **6**, 601, 1898, **25**, 185, 1908, **35**, 128; *Am. J. Pharm.* 1879, **51**, 325; *Bay. Ind. und. Gewerbebl.* 1880, **12**, 56; *Bull. Musee.* **77**, 101; *Bay. Ind. und. Gewerbebl.* 1885, **17**, 227; *Bulletin de Rouen.* 1884, 525; *J. C. S.* 1885, 1006; *Minutes Pharm. Meeting Phila.* Jan. 19, 1886; abstr. *Am. J. Pharm.* 1886, **58**, 106; *Iron Age.* 1887, **24**, Nr. 26; *La Nature.* 1890, 11, 286, **22**, 370; *Z. Bursten.* 1891, **14**, 257; *Ind.* **10**, 571; *Man. Bldr.* 1891, **23**, 276; *Gumm. Ztg.* 1896, **10**, 22; *Gew. Bl. Wurt.* 1901, **53**, 299; *Am. Mach.* 1901, **27**, 1105; *Tex. Col.* 1905, **27**, 360; *Proc. Amer. Pharm. Assoc.* **26**, 156; *Gew. Ztg.* **45**, 143; *Ind. Ztg.* **21**, 65; *Mon. Sci.* 1882, **24**, 696; *Orgelb. Ztg.* **2**, 255; *Papier. Ztg.* **5**, 812; *Sc. Am.* **45**, 48; *Sc. Am. Suppl.* 4224; *Techniker* **2**, 71, 102; *Tischl. Ztg.* **7**, 71; *D. R. P.* 206471; *Bay. Ind. und. Gewerbebl.* 1909, **41**, 314.
- 3 U. S. P. 534445, 1895.
- 4 E. P. 5057, 1878.
- 5 E. P. 296811, 1901.
- 6 U. S. P. 996191, 1911; *D. R. P.* 214962, 1906, abstr. *J. S. C. I.* 1909, **28**, 1270; *Jahr. Chem.* 1909, **62**, 391.
- 7 *Chem. Ztg.* 1902, **26**, 475, abstr. *Jahr. Chem.* 1902, **55**, 1056; *Annales D'Hyg. Publiq. et de Med. Legale* 1886, (3), **12**, 275; **16**, 470.
- 8 *D. R. P. Ann. C.* 27654; abstr. *Chem. Zentr.* 1919, **90**, 11, 388.
- 9 *Aust. P.* 6712, 1901.
- 10 E. P. 2249, 1860.
- 11 *Belg. P.* 201939, 1908.
- 12 E. P. 18822, 1912, abstr. *J. S. C. I.* 1913, **32**, 907.
- 13 *Belg. P.* 184896, 1905.
- 14 U. S. P. 677012, 1901.
- 15 E. P. 1857, 1881, abstr. *J. S. C. I.* 1885, **4**, 68, 229.
- 16 E. P. 15121, 1884, abstr. *Ber.* 1886, **19**, 126.
- 17 *Bull. Soc. Chim.* 1874, **21**, 572; *Wag. Jahr.* 1874, **20**, 924; *Chem. Tech. Rep.* 1874, **13**, 11, 157.
- 18 *Dingl. Poly.* 1881, **239**, 62, abstr. *Chem. Centr.* 1881, **52**, 154.
- 19 U. S. P. 964483, 1910, abstr. *Mon. Sci.* 1911, **75**, 12.
- 20 *Belg. P.* 189912, 1906.
- 21 *Belg. P.* 189469, 1906.
- 22 *Sci. Amer.* 1910, **102**, 361; *Cosmos*, 1910, **59**, 152.

Buchstab,¹ Celluloid Mfg. Co.,² T. Bolas and Selt Developing Plate Co.,³ E. Clement,⁴ P. Cottrell,⁵ L. Desvaux and H. Allaire,⁶ T. Didier,⁷ E. I. duPont de Nemours Powder Co.,⁸ Dusseldorfer Celluloidfabrik G. m. b. H.,⁹ J. Ertel,¹⁰ J. France,¹¹ P. Germain,¹² C. Gillet,¹³ B. Goldsmith,¹⁴ F. Greening and J. Frost,¹⁵ C. Hagemann and F. Zimmermann,¹⁶ S. Halen,¹⁷ Emil Heuser,¹⁸ W. Hogben,¹⁹ S. Hoggson and G. Pettis,²⁰ Houben and Wooldridge,²¹ J. Kitsee,²² G. Koller,²³ E. Beutinger,²⁴ M. Delpy,²⁵ F. Lehmann,²⁶ W. Lindsay,²⁷ G. Magnus & Co.,²⁸ E. Manter,²⁹ Marcellac and Sournet,³⁰ E. I. du Pont de Nemours Powder Co.,³¹ W. McCaine,³² J. McClellan,³³

1. D. R. P. 214398, 1908; abst. J. S. C. I. 1909, **28**, 1221. F. P. 408406, 1909.
2. E. P. 878, 1878. See also E. P. 2101, 1870, 3101, 1872.
3. U. S. P. 964483, 1910.
4. E. P. 10420, 1910.
5. E. P. 3376, 1881, abst. J. S. C. I. 1882, **1**, 159.
6. Aust. P. 40483, 1909; Addn. to Aust. P. 27293.
7. Belg. P. 180006, 1904. See also Societe Matray Freres et Cie, F. P. 296811, 1900.
8. D. R. P. 292951, 1912; Aust. P. 67676. E. P. 22623, 1912. Swiss P. 63137, 1912.
9. E. P. 17009, 1912; F. P. 446270, 1912; abst. C. A. 1913, **79**, 1972; J. S. C. I. 1913, **32**, 133; Kunst. 1913, **3**, 96. D. R. P. Ann. D. 25590, 1911; abst. Zts. ang. Chem. 1912, **25**, 1885.
10. "Der Celluloid Industrie," Leipzig, 1909.
11. E. P. 17692, 1888; abst. J. S. C. I. 1888, **7**, 881; 1889, **8**, 160, 303.
12. Belg. P. 180718, 180719, 1905.
13. F. P. 382270, 382250, 1906; abst. J. S. C. I. 1908, **27**, 244.
14. U. S. P. 1152625; abst. C. A. 1915, **9**, 2800.
15. U. S. P. 401269; E. P. 8442, 1886; F. P. 184247; Belg. P. 57879.
16. U. S. P. 657335, 1900. Cf. R. Robertson and W. Rintoul, U. S. P. 723311, 1903. H. Dow, U. S. P. 1339552, 1920; abst. J. S. C. I. 1920, **39**, 483-A.
17. Kunst. 1914, **4**, 329; abst. C. A. 1915, **9**, 148.
18. Pap. Ztg. 1915, **40**, 307, 355, 379; abst. C. A. 1915, **9**, 1690.
19. J. S. C. I. 1892, **11**, 222; abst. Jahr. Chem. 1892, **45**, 2896. Amer. Gas. J. 1892, **57**, 77. See also E. Hermite, Jahr. Chem. 1888, **41**, 2851.
20. U. S. P. 245952, 1881.
21. E. P. Appl. 6922, 1916; abst. J. S. C. I. 1917, **36**, 51.
22. U. S. P. 701357, 1902; abst. J. S. C. I. 1902, **21**, 925.
23. Belg. P. 243162, 1912. Hung. P. Appl. K. 5099.
24. Kunst. 1911, **1**, 10.
25. Kunst. 1914, **4**, 158. Cf. Kunst. 1911, **1**, 261.
26. D. R. P. 297149, 1913; U. S. P. 1191801; E. P. 7300, 1914.
27. U. S. P. 961360, 1910; abst. J. S. C. I. 1910, **29**, 875, 1911, **30**, 279; E. P. 13692, 1910; abst. Kunst. 1911, **1**, 171, 235. U. S. P. 1233371, 1917; abst. J. S. C. I. 1917, **36**, 1004. See also E. Lott, Gummi Ztg. Suppl. 1906, **2**, 19.
28. D. R. P. 8273; abst. Chem. Tech. Rep. 1880, **19**, 1, 179.
29. Elec. J. 1919, **16**, 94; abst. C. A. 1919, **13**, 906.
30. F. P. 271256, 1900.
31. E. P. 22623, 1912; abst. J. S. C. I. 1913, **32**, 1105.
32. U. S. P. 217232, 1879; abst. J. A. C. S. 1879, **1**, 306.

land,¹ S. Medveczky,² Nagel,³ Schreiner and Sievers,⁴ T. Nicholls and W. Nicholls,⁵ M. Ortmann,⁶ E. Peyrusson,⁷ Rheinische Gummi u. Cell. Fabrik,⁸ J. and C. Schmerber and L. Morane,⁹ Societe Anonyme Nouvelle L'Oyonnithie,¹⁰ W. Stevens,¹¹ A. Spiller,¹² B. Szelinski,¹³ O. Thiele,¹⁴ Thommee,¹⁵ V. Tribouillet and L. Besancele,¹⁶ J. Varley,¹⁷ Vincent,¹⁸ E. Weston,¹⁹ H. Wertheim,²⁰ A. Williams and W. Parkin,²¹ and W. Zeidler.²²

Re-working celluloid.²³ It often becomes necessary to first soften (plasticize) celluloid. The processes of H. Cave-Brown-Cave,²⁴ S. Germain,²⁵ H. Goetter,²⁶ V. Krieg,²⁷ A. Püschel,²⁸ J. Simon and Dürkheim,²⁹ and G. Thompson³⁰ are applicable for this purpose.

1. U. S. P. 90766, 96132, 1869. F. P. 86144, 1869.
2. U. S. P. 1012887, 1911; E. P. 27283, 1910; Swiss P. 58686; abst. Kunst. 1913, **3**, 258.
3. F. P. 254695, 1896; abst. Mon. Sci. 1897, **50**, 21.
4. N. Erfind. Erfahr. 1892, **19**, 523.
5. E. P. 2073, 1882.
6. E. P. 5280, 1904; F. P. 342464, 1904; abst. J. S. C. I. 1904, **23**, 049; 1905, **24**, 344.
7. F. P. 374395, 1906.
8. D. R. P. 109738, 1890; abst. Chem. Centr. 1900, **71**, II, 231.
9. U. S. P. 233558, 1880; E. P. 4863, 1903. Caout. et guttap. **8**, 4783, 4861, 5158, 5450, 5536; abst. C. A. 1911, **5**, 3730. F. P. 324121, 1902; abst. J. S. C. I. 1903, **22**, 569.
10. F. P. 465345; abst. Kunst. 1914, **4**, 215.
11. E. P. 4390, 1908; abst. J. S. C. I. 1909, **28**, 381.
12. D. R. P. 247734; abst. Kunst. 1913, **3**, 389; C. A. 1912, **6**, 2550; Zts. ang. Chem. 1912, **25**, 1748.
13. N. Erfind. Erfahr. 1908, **35**, 429.
14. E. P. 13823, 1894.
15. Rev. Tech. 1905, **26**, 372.
16. E. P. 5057, 1878; D. R. P. 6828, 1879; abst. Dingl. Poly. 1880, **235**, 203; Ind. Blatt, 1879, 365; Wag. Jahr. 1879, **25**, 111; Chem. Tech. Rep. 1879, **18**, II, 135; Hofman Pap. Ztg. 1879, 738.
17. U. S. P. 321548, 1885. See also E. P. 9205, 1884; D. R. P. 30066, 1884; F. P. 163102, 1884; Can. P. 20726, 1884.
18. Bull. Soc. d'Encour. 1881, 238; abst. Wag. Jahr. 1881, **27**, 949.
19. U. S. P. 264987, 1882.
20. E. P. 6268, 1912; abst. J. S. C. I. 1913, **32**, 420.
21. E. P. 8301, 1901; abst. J. S. C. I. 1902, **21**, 719.
22. E. P. 8012, 1885; abst. J. S. C. I. 1885, **4**, 609.
23. Merck's Report, 1908, **17**, 277; 1910, **19**, 82, 326.
24. E. P. 22299, 1903; abst. J. S. C. I. 1904, **23**, 909; D. R. P. 178944, 1904; abst. C. A. 1907, **1**, 1903; Zts. ang. Chem. 1907, **20**, 1541; Chem. Zentr. 1907, **78**, I, 917; Jahr. Chem. 1905-1908, II, 993; Wag. Jahr. 1907, **53**, II, 561.
25. Belg. P. 180720, 1905.
26. U. S. P. 597144, 1898.
27. D. R. P. 146432, 1904; abst. Wag. Jahr. 1904, **50**, II, 511.
28. E. P. 18105, 1913; abst. C. A. 1915, **9**, 377.
29. Swiss P. 76546, 1918; abst. C. A. 1918, **12**, 1420.
30. Brit. Med. J. 1916, II, 801; abst. C. A. 1917, **11**, 1300.

In the molding or casting¹ of celluloid articles, depending upon their size or configuration, a bewildering number of methods have been proposed, principal among which may be noted J. Hyatt,² R. Hunt,³ H. Miller,⁴ D. Lockwood,⁵ M. Davis,⁶ J. Furman,⁷ I. Hyatt,⁸ J. Edson,⁹ F. Eckstein,¹⁰ J. Dunlop,¹¹ K. Collins,¹² J. Everding,¹³ W. Ker,¹⁴ A. Bacigalupi,¹⁵ Baldauf Bros.,¹⁶ D. Berry,¹⁷ E. Bluemel,¹⁸ J. Brockway,¹⁹ G. Burns and D. Chandler,²⁰ O. Butin,²¹ W. Carpenter,²² J. Chazeile,²³ Convert,²⁴ J. Craig,²⁵ F. Damm,²⁶ M. Davis,²⁷ J. Denbeigh,²⁸ E. Dent,²⁹ M. Dessau,³⁰ J. Dixon,³¹ A.

1 O. Chase, U. S. P. 484777, 1892. *Jahr Chem* 1877, **30**, 1223; *Dingl Poly* 1877, **225**, 520. *Gummi Ztg* 1899, **14**, 19. *Photography*, 1902, **14**, 31, 521. In this connection see C. Grasser, E. P. 2500, 1876; J. Gartrell, E. P. 5117, 1879; I. Hyatt, E. P. 1480, 1881; J. Wirth, E. P. 9604, 1886; E. Dent, E. P. 16009, 1890; L. Marc, E. P. 349, 1892; P. Reidel, E. P. 21409, 1893; G. Littlefield, E. P. 24614, 1894; S. Learoyd and E. Bluemel, E. P. 11706, 1895; C. Rott, E. P. 9737, 1898; O. Butin, E. P. 27001, 1898; F. Reddaway and M. Desau, E. P. 4235, 1901; F. Germann, E. P. 24205, 1901; Ges. f. Huberpressung, E. P. 1225, 1902; D. Berry, E. P. 1377, 1902; C. Mackenzie and Inst. Physical and Political Geography Maps, E. P. 3457, 1904; H. Dover, E. P. 9321, 1905; F. Egge and N. Beach, E. P. 7001, 1896; E. Kempshall, E. P. 5925, 1896; E. Sperry, E. P. 5569, 1900; L. Duchesne, E. P. 1728, 1881.

2 U. S. P. 105338, 1870, 152232, 180133, 200914, 230791, 1881; 239793, 236678, 259984, 265229, 280745; Re. 5928, 10469, 10546, 1874 to U. S. P. 105338. E. P. 3101, 1872. See also Z. Bursten, **27**, 355.

3 U. S. P. 162752, 1875.

4 U. S. P. 488570, 1892, 534446, 1895. See also J. Stevens, U. S. P. 559823, 1896.

5 U. S. P. 251260, 1881.

6 U. S. P. 259826, 1882.

7 U. S. P. 282451, 1883, 365768, 369784, 1887.

8 U. S. P. 275216, 1883. I. and J. Hyatt, E. P. 2101, 1870.

9 U. S. P. 283224, 1883, 349987, 1886, 356108, 1887.

10 U. S. P. 458157, 1891.

11 E. P. 1908, 1884.

12 U. S. P. 405874, 1889.

13 U. S. P. 286535, 1883.

14 U. S. P. 826781, 1906; F. P. 366891, 1906.

15 E. P. 20873, 1911. See also C. Arnold, U. S. P. 1195431; *abst Kunst.* 1919, **9**, 137.

16 Aust. P. 6712, 1902.

17 E. P. 1377, 1902.

18 E. P. 17496, 1889.

19 U. S. P. 113735, 1871.

20 U. S. P. 597929, 1898.

21 E. P. 27001, 1898.

22 U. S. P. 237168, 1881; E. P. 431, 1881.

23 F. P. 465250, *abst Kunst.* 1914, **4**, 381.

24 F. P. 335694, 1903.

25 E. P. 21002, 1914; *abst J. S. C. I.* 1915, **34**, 1204.

26 U. S. P. 496399, 1893.

27 U. S. P. 259826, 1882.

28 U. S. P. 498206, 1893.

Diss.,¹ D. Dorsett,² I. Duchesne,³ C. Du Puy,⁴ A. Eichengrün,⁵ P. Ford & Sons and H. Ford,⁶ J. France,⁷ J. Gartell,⁸ H. Gautier,⁹ Ges. f. Huberpressung,¹⁰ T. Gibson,¹¹ G. Grasser,¹² C. Gray,¹³ H. Gunthner,¹⁴ C. Hemje and T. Brecht,¹⁵ H. Hinterstoisser,¹⁶ J. Hoffman,¹⁷ C. Huber,¹⁸ F. Hunt,¹⁹ M. Hunter and J. Clark,²⁰ P. Hunaeus,²¹ C. Iles,²² P. Jäger & Sohne,²³ L. Jannin,²⁴ A. Jarman,²⁵ R. Johnson,²⁶ E. Jordan,²⁷ E. Kepper,²⁸ W. Kilian,²⁹ Kohl & Wengenroth,³⁰ A. and F. Kube,³¹ M. Lamy,³² S. Learoyd and E. Bluemel,³³ W. Lindsay,³⁴ G. Littlefield,³⁵ J. Low and H. Streeter,³⁶ G. Ludovici,³⁷ N. Ludwig,³⁸ F. Ludi and J. McMillan,³⁹ E. Kempshall,⁴⁰

- 29 E. P. 16069, 1890
- 30 U. S. P. 998474, 1911
- 31 U. S. P. 608512, 1898
- 1 U. S. P. 278321, 1883
- 2 U. S. P. 302549, 1884
- 3 E. P. 1728, 1881
- 4 U. S. P. 296825, 1884
- 5 Can. P. 42983, 1910
- 6 E. P. 4289, 1915
- 7 U. S. P. 393752, 1888
- 8 E. P. 5112, 1878, 5117, 1879, 3750, 1882
- 9 Conseil d'Hygiene Publique, Oct. 8, 1915, 384, 389.
- 10 E. P. 1225, 1902
- 11 E. P. 2985, 1881
- 12 E. P. 2500, 1876
- 13 U. S. P. 590115, 1897, E. P. 9353, 1896, F. P. 256208, 1896.
- 14 E. P. 1521, 1911, abst. Kunst. 1912, **2**, 215
- 15 U. S. P. 279384, 1883
- 16 Wien. klm. Wochschr. 1894, **7**, 63
- 17 U. S. P. 516814, 1894
- 18 U. S. P. 731367, 1903 See also K. Lengfellner, D. R. P. 206223;
- Aust. P. 41106, 1909
- 19 U. S. P. 162752, 1874
- 20 U. S. P. 492206, 1893
- 21 E. P. 15868, 1890 D. R. P. 68752, abst. Wag. Jahr. 1893, **39**, 1118
- 22 E. P. 818, 1899
- 23 Aust. P. 62395, abst. Kunst. 1914, **4**, 156
- 24 D. R. P. 14892, 1880 E. P. 1422, 1879
- 25 U. S. P. 1007440, 1911
- 26 U. S. P. 217111, 1879
- 27 U. S. P. 523430, 1894
- 28 U. S. P. 335526
- 29 U. S. P. 296183, 1884
- 30 D. R. P. 172622
- 31 E. P. 9591, 1904
- 32 F. P. 380210, 1906
- 33 E. P. 11706, 1895
- 34 U. S. P. 1292819, abst. C. A. 1919, **13**, 1017.
- 35 E. P. 24614, 1894
- 36 U. S. P. 335528, 1886
- 37 D. R. P. 170196, abst. Wag. Jahr. 1906, II, 527.
- 38 D. R. P. 197153, 1908, abst. Zts. chem. Ind. Koll. 1908, **3**, 109;

W. McCaine,¹ S. McCarter,² J. McClelland,³ P. Meyer,⁴ V. Montain,⁵ E. Muller,⁶ F. Nickerson,⁷ A. Nienstadt,⁸ F. Oliver,⁹ O. Freres,¹⁰ H. Parker,¹¹ G. Philipp,¹² A. Pope,¹³ N. Poulson,¹⁴ R. Rausch,¹⁵ Rhein. G. & C. Fabrik,¹⁶ G. Rishel,¹⁷ V. Roybier,¹⁸ V. Schulmers,¹⁹ Sciamengo and Pastrone,²⁰ Soc. A. Oher & Co.,²¹ Soc. "LaBelhig nite,"²² A. Spalding and Bros.,²³ K. Standfuss,²⁴ G. Stevens,²⁵ Stubling,²⁶ A. Talobre and E. Bertrand,²⁷ J. Thalmann,²⁸ E. Villiers,²⁹ Vuagnat and Gaget,³⁰ C. Weller,³¹ J. Wirth,³² Erster Celluloid waren-Fabrik,³³ and L. Marc.³⁴

Cutting of celluloid. This is detailed in the methods as published by J. Everding,³⁵ E. Kupper,³⁶ Soc. Vuagnat and Gaget,³⁷

- Wag. Jahr. 1908, **54**, II, 540.
39. U. S. P. 1237352, 1917. Can. P. 185721, 1918.
 40. Can. P. 79695, 1903.
 1. U. S. P. 217232, 1878.
 2. U. S. P. 304337, 1884.
 3. U. S. P. 143772, 1873.
 4. E. P. 2256, 1902.
 5. E. P. 458023, abst. Kunst. 1914, **4**, 56.
 6. E. P. 8706, 1912; E. P. 456428, 1912, abst. Kunst. 1913, **3**, 452.
 7. U. S. P. 285057, 285058, 285059, 1883.
 8. U. S. P. 1295356, abst. C. A. 1919, **13**, 1248.
 9. E. P. 17001, 1894.
 10. D. R. P. 221099, abst. Wag. Jahr. 1910, **56**, II, 588.
 11. U. S. P. 495228.
 12. D. R. P. 273560, 1911, abst. Kunst. 1914, **4**, 214.
 13. E. P. 22414, 22415, 1897.
 14. U. S. P. 550133, 1895.
 15. Aust. P. 45412, 1910.
 16. D. R. P. 112770, abst. Wag. Jahr. 1900, **46**, II, 565.
 17. U. S. P. 287723, 1883. Re. 10412, 1884.
 18. E. P. 440485, abst. Kunst. 1912, **2**, 116.
 19. E. P. 9268, 1911.
 20. D. R. P. Ann. J. 11037, 1911.
 21. E. P. 434455, abst. Kunst. 1912, **2**, 214.
 22. Belg. P. 202820, 1907.
 23. E. P. 9353, 1897.
 24. D. R. P. 125620, 1901, abst. Jahr. Chem. 1901, **54**, 900; Wag. Jahr. 1901, **47**, II, 609.
 25. U. S. P. 607600, 1901.
 26. Celluloid, 1904, **5**, 9.
 27. E. P. 462126, abst. Kunst. 1914, **4**, 294.
 28. D. R. P. Ann. T. 14390, 1909, abst. Kunst. 1912, **2**, 260.
 29. U. S. P. 233898, 1880.
 30. D. R. P. 235814, 1910, abst. Kunst. 1911, **1**, 277; E. P. 412710.
 31. U. S. P. 303081, 1884.
 32. E. P. 9604, 1888. See also O. Whitcomb, Can. P. 11073, 1880.
 33. D. R. P. Ann. Z. 8844, 1911, abst. Kunst. 1914, **4**, 179.
 34. E. P. 349, 1892.
 35. U. S. P. 286535, 1883.
 36. U. S. P. 290803, 1884.
 37. E. P. Adm. 12713 to 402710, 1910.

and C. Smith.¹ In the cleaning, polishing, pumicing and preserving of celluloid,² made necessary from the fact that when the sheets are planed from a block or cake, there appears on the surface fine lines caused by the serrations in the edge of the cutting knife, much ingenuity has been expended. The methods in present use are the outcome of the inventions of W. Schmidt,³ J. Edson,⁴ W. Zeidler,⁵ R. Besel,⁶ E. Chappuis,⁷ V. Dunne,⁸ W. Homberger,⁹ Kraemer and van Elsberg,¹⁰ A. Püschel,¹¹ L. Lilienfeld,¹² E. Luce,¹³ P. Meissner,¹⁴ J. Martin,¹⁵ P. Pounnier,¹⁶ Rheinische Gummi and Celluloid Fabrik,¹⁷ Kleinmann,¹⁸ W. Schmidt,¹⁹ J. Stevens and W. Wood,²⁰ and W. Zeidler.²¹ Any solvent of celluloid makes a good polishing agent, where heat is not used.

Inlaying metal goods with celluloid (metallic incrustations). Beautiful effects may be obtained and articles of usefulness produced. The general methods of celluloid inlaying are fully dealt with in the writings of H. Aumont,²² G. Abraham,²³

1. E. P. 16861, 1899.
2. A. Petit, D. R. P. 119127, 1899; 119363, 1900. Amat. Phot. 1891, **14**, Q 285, A 326, 346. Z. Bürsten, **25**, 489. Jahr. Phot. 1906, **20**, 599, Amat. Phot. 1904, **39**, 199. Drug. Circ. 1911, 427. N. Erfin. Erf. 1911, **38**, 138. Bull. Pharm. 1912, 220. Cosmos, 1907, **56**, 166; 1908, **58**, 390; Techn. Rundschau; abst. Zahnärztl. Wochenschr.; Dental Cosmos, 1915, **57**, 470.
3. U. S. P. 465784, 1891.
4. U. S. P. 221070, 1879; 283224, 289240, 289242, 290553, 289239, 1883; 297770, 1884.
5. E. P. 8012, 1885; abst. J. S. C. I. 1885, **4**, 609.
6. F. P. 459187.
7. E. P. 21543, 1897.
8. U. S. P. 730102, 1903.
9. Aust. P. 20804, 1905; E. P. 17232, 1904; abst. J. S. C. I. 1904, **23**, 997. F. P. 345405, 1904; abst. J. S. C. I. 1904, **23**, 1234; D. R. P. 163912; abst. Wag. Jahr. 1905, **51**, II, 570.
10. F. P. 451398, 1912.
11. E. P. 18105, 1913.
12. E. P. 14483, 1903. U. S. P. 834739; abst. J. S. C. I. 1906, **25**, 1143. D. R. P. 182773; abst. J. S. C. I. 1903, **22**, 694.
13. F. P. 465274; abst. Kunst. 1914, **4**, 381.
14. D. R. P. 101868, 1896; abst. Chem. Centr. 1899, **70**, I, 1142. E. P. 12870, 1896.
15. F. P. 452342, 1912.
16. F. P. 435417; abst. Kunst. 1912, **2**, 195; J. S. C. I. 1912, **31**, 381.
17. D. R. P. Anm. R-29264.
18. Vierteljschr. f. Zahn. **20**, 126.
19. U. S. P. 465784, 1891.
20. U. S. P. 329093, 1885; see also Stübling, Gummi-Ztg. **19**, 982.
21. Can. P. 21636, 1885. E. P. 8012, 1885.
22. U. S. P. 530817, 1894; E. P. 4203, 1894.
23. E. P. 8826, 1911.

La Bellignite,¹ V. Blüthgen,² D. Cohen,³ O. Corwin,⁴ W. Edge,⁵ E. Gilmant,⁶ G. and A. Gornitzka,⁷ E. Grasset and S. Hassmann,⁸ Halbach and Böckmann,⁹ H. Heede,¹⁰ G. Hirst,¹¹ J. Hyatt,¹² J. Kaufmann,¹³ Neubauer, Grotte and Kalous,¹⁴ and F. Nickerson.¹⁵

Dyeing of pyroxylin plastics. This is a highly developed art,¹⁶ its details being elucidated from the descriptions of A. Alian,¹⁷ N. Hart and R. Bacon,¹⁸ E. Batonnier and P. Michel,¹⁹ R., J. and F. Carmichael,²⁰ L. Dangy,²¹ T. Edison,²² La Compagnie Francaise du Celluloid,²³ M. Krause,²⁴ E. Stich,²⁵ O. Lange,²⁶ F. Lehner,²⁷ H. Ligny,²⁸ Monin,²⁹ F. Nickerson,³⁰ C. Späth,³¹ F. Springmuehl,³²

1. F. P. 402163, 1908
2. U. S. P. 293408, 1884.
3. E. P. 25149, 1910
4. U. S. P. 233076, 1880.
5. U. S. P. 272032, 272033, 1883
6. F. P. 399122, 1908.
7. E. P. 400, 1911
8. F. P. 401283, 1909.
9. D. R. P. Anm. H-54205, 1911
10. Ber. 1892, **25**, 822
11. U. S. P. 285019, 1882.
12. U. S. P. 119710, 1871.
13. E. P. 10757, 1911; F. P. 248880, 1911; D. R. P. 240501, 240904, abst. C. A. 1912, **6**, 2150.
14. Zts. f. Elektrochem. 1903, **9**, 153. D. R. P. 139447; abst. Wag. Jahr. 1903, **49**, I, 233.
15. J. S. C. I. 1882, **1**, 147.
16. Neue. Erfind. Erfahr. 1890, **17**, 423; 1892, **19**, 494. Chem. Centr. 1893, **64**, I, 1099. Bayer Ind. Gewerbl. 1891, **23**, 429; 1893, **25**, 212; 1894, **36**, 239. Z. Bursten, 1898, **17**, 277. Amat. Photog. 1902, **36**, 80. Maler Z. 1907, **27**, I. Drug Circ. 1911, **55**, 427, 640. Celluloid Ind. 1911, **12**, 45; Kunst. 1911, **1**, 450. Cosmos, 1912, **66**, 112. Kunst. 1915, **5**, 60. K. Micksch, Kunst. 1919, **9**, 99, 126.
17. D. R. P. 61044, 1892; abst. Wag. Jahr. 1892, **38**, 1067; Eders Jahr. 1893, **7**, 527.
18. U. S. P. 233851, 1880; Can. P. 12163, 1880.
19. E. P. 2326, 1880.
20. E. P. 22095, 1902; abst. J. S. C. I. 1903, **22**, 92.
21. Belg. P. 254893, 1914. See also G. and A. Gornitzka, E. P. 400, 1911.
22. U. S. P. 234450; abst. C. A. 1917, **11**, 260. See also J. Kestner, D. R. P. 160378, Wag. Jahr. 1905, **51**, II, 571.
23. E. P. 9874, 1886.
24. E. P. 16913, 1902
25. Kunst. 1913, **3**, 286, 385.
26. D. R. P. 126734.
27. E. P. 7629, 1908; abst. J. S. C. I. 1909, **28**, 109.
28. F. P. 386846, 1907.
29. F. P. 293199, 1899; abst. Mon. Sci. 1901, **57**, 30.
30. U. S. P. 251924, 1882.
31. D. R. P. 267992, 1913; abst. Chem. Zentr. 1914, **35**, I, 207; C. A. 1914, **8**, 1668; Kunst. 1914, **4**, 75. D. R. P. Anm. S-34159, 1911; abst. Kunst. 1913, **3**, 340.
32. Muster Ztg. 1872, No. 20; Poly. Centr. 1872, **38**, 827; Wag. Jahr. 1872, **18**, 816.

E. Stich,¹ Verein. Kunstseidefabr.,² W. Williams,³ R. Malcolm,⁴ British Xylonite Co.,⁵ and E. Ogawa.⁶

Forming pyroxylin plastics into sheets⁷ is one of the more important operations in the celluloid industry, and was first accomplished by passing through heavy rolls, but the edges cracked and crazed and otherwise became unmanageable. This was afterwards replaced by a planing or shaving mechanism. Details of this branch are to be found in the inventions of J. Hyatt,⁸ D. Lockwood,⁹ A. Abel,¹⁰ Actien-Gesellschaft f. Anilin-Fabrikation,¹¹ A. Alombert and J. Bondivenne,¹² B. Atcker,¹³ J. Battis and A. Goodell,¹⁴ E. Benedictus,¹⁵ J. Blum,¹⁶ V. Blumm,¹⁷ B. Borzykowski,¹⁸ J. Bourgeois, E. Nieuviarts and V. de Clercq,¹⁹ J. Brandenberger,²⁰ H. Child,²¹ F. Curtis,²² P. Durando,²³ J. Edson,²⁴ J. Field,²⁵ H. Haskell,²⁶ C. and J. Hays,²⁷

1. Kunst 1913, **3**, 286, 325, abst C A 1914, **8**, 245.
2. F P 395165, 1908, abst J S C I 1909, **28**, 329 C A 1910, **4**, 119, E P 218410, 1908, abst J S C I 1909, **28**, 627.
3. U S P 916516, 1909.
4. U S P 1332349, 1920, abst C A 1920, **14**, 1219.
5. D R P 43002, abst Chem Tech Rep. 1888, **27**, 1, 98.
6. Jap P 35042, 1919, abst C A 1920, **14**, 2401.
7. Anthony, Photo Bull 1890, **21**, 298, Amat Photog 1890, **12**, 418, 1891, **14**, 285, 326, 346, Meyer Jahr Chem 1891, **1**, 513, Bayer Ind Gewerbl 1901, **33**, 348 N. Erfind. Erfahr 1901, **28**, 38, 1902, **29**, 548 Photog 1901, **13**, 467. Cosmos, 1909, **61**, 306.
8. U S P 205271, 1878; 199908, 1878, 275215, 1883, 275216, 1883, 301995, 1884, 199908, 1878, 205271, 1878, 221070, 1879.
9. U S P 205880, 1878.
10. E P 7588, 1913.
11. Aust P Ann A-2756, 1905 F P 349884, 1904, E P 9962, 1904; abst J S C I 1905, **24**, 248, 855 E P 9962, 1904, F P 349884, 1904.
12. F P 392781, 1908.
13. D R. P 111195, 1899, abst Mon Sci 1901, **57**, 23, Wag. Jahr 1900, **46**, II, 565.
14. E P 13962, 1902.
15. U S P 1068342, abst Kunst 1915, **5**, 56 F. P. 405881, 1909.
16. F P 392870, 1907.
17. Viertelschr f Zahn 1897, **19**, 224.
18. D. R. P 281424, 1911, abst C A 1915, **9**, 2168.
19. F P 434602, 1910.
20. E P 27322, 1912.
21. Bayer Ind u Gewerbel 1880, **12**, 309.
22. U S P 387947, 1888, 386110, 1888.
23. F P 464998, 1913 F. P 463149, 1913.
24. U S P 349987, 1886 277692, 1883; 283224, 1883, 290553, 1883.
25. E. P 26682, 1908; 16010, 1909.
26. U S P 935603, 1909.
27. U. S. P. 253864, 1882.

E. Hillaby,¹ H. Dover,² P. Jaeger and Son,³ P. Janks,⁴ J. Jarvis,⁵ E. Kempshall,⁶ E. Kipper,⁷ C. Koyl,⁸ Le Faguays,⁹ F. Miller,¹⁰ A. Mitteloche,¹¹ J. Najlar,¹² C. Rosier,¹³ Quentm,¹⁴ O. Schaumann,¹⁵ Celluloid-Fabrik. Schreiner and Sievers,¹⁶ C. Sciamengo,¹⁷ B. Slade,¹⁸ Soc. Civile des Pellicules Nouvelles,¹⁹ Triplex Safety Glass Co.,²⁰ Soc. Industrielle de Photographie,²¹ C. Spath,²² J. Stevens and M. Lefferts,²³ L. Tiorillo,²⁴ C. Tootell,²⁵ G. West,²⁶ Z. Wolff, E. Silbermann, J. Silbermann and J. Moscovitz.²⁷

In the formation of sheets for balloons, the methods of H. Dittmar,²⁸ J. Fields,²⁹ A. Krumholz and R. Rausch,³⁰ and H. Segall³¹ are applicable. Stained celluloid sheets as a substitute for glass has had wide application,³² and many are the processes which have been elaborated in this direction. Principally among

1. E. P. 20426, 1911, abst. C. A. 1916, **10**, 958.
2. E. P. 891, 1911.
3. Aust. P. 62395, 1913.
4. P. Janks, Photo. Corres. 1898, **35**, 221.
5. J. Jarvis, D. R. P. 54819, abst. Ber. 1891, **24**, 606; Wag. Jahr. 1891, **37**, 1176.
6. Aust. P. 17137, 1901.
7. U. S. P. 299863, 1884.
8. D. R. P. 58500, abst. Ber. 1892, **25**, R, 229.
9. E. P. 15276, 1910.
10. E. P. 25256, 1912.
11. D. R. P. 82833, 1895, abst. Wag. Jahr. 1895, **41**, 1088.
12. E. P. 11009, 1882.
13. F. P. 422423, 1910.
14. Aust. P. 58303.
15. U. S. P. 1007144, abst. C. A. 1912, **6**, 72.
16. D. R. P. 67912, 1892, abst. Ber. 1893, **26**, R, 517.
17. U. S. P. 1036730, abst. C. A. 1912, **6**, 3329.
18. E. P. 23092, 1910.
19. F. P. 384112, abst. J. S. C. I. 1908, **27**, 471; and Addn. of July 6, 1907, abst. J. S. C. I. 1908, **27**, 1081.
20. E. P. 15386, 1913.
21. F. P. 430086, 1910.
22. F. P. 421119, 1910.
23. U. S. P. 600824, 1898.
24. Swiss. P. 44228, 1907.
25. E. P. 1256, 1911. See also P. Pommer, F. P. 135117, 1910.
26. E. P. 11598, 1913.
27. F. P. 361740, 1905.
28. E. P. 2064, 1911.
29. E. P. 26682, 1908, 16010, 1909.
30. E. P. 3853, 1911, D. R. P. Ann. K-42029, 1909, D. R. P. 232186, 1909, abst. C. A. 1912, **6**, 824.
31. U. S. P. 1322631, abst. C. A. 1920, **14**, 345.
32. Chem. Tech. Rep. 1885, **24**, 1, 171. Camera, 1888-1889, **3**, 193. Photo. Corres. 1889, **26**, 177. Anthony Phot. Bull. 1888, 726. Wilson's Photog. Mosaics, 1890, 10, LeMon. de la Photog. 1891, **30**, 176.

them may be selected those of Balaguy,¹ A. Bardin,² Bäumcher & Co.,³ E. Benedictus,⁴ R. Hansel,⁵ David,⁶ F. Eckstein,⁷ Fortier,⁸ J. Fowler,⁹ H. Fritsch,¹⁰ P. Laujorrais,¹¹ S. Goldreich, C. McKerrow and Splinterless Antimist Glass Syndicate,¹² J. Harcombe,¹³ W. Lyttleton and Triplex Safety Glass Co.,¹⁴ S. de Medvezsky,¹⁵ Ott Bros.,¹⁶ G. Pelmeur, W. Cummings and W. Meggeson,¹⁷ A. Roosevelt,¹⁸ U. Wolkersdorfer,¹⁹ and W. Williams.²⁰

The above includes the processes for producing strengthened splinterless, triplex and non-shattering glass.

Veneering with celluloid. This comprizes covering articles with thin celluloid sheets, and causing a permanent union by heat and pressure. Such processes are covered by the advances of C. Church,²¹ J. France,²² A. Hafely, J. Redleisen and C. Happe,²³ F. Hainker,²⁴ W. Küll,²⁵ J. McClelland,²⁶ E. and B. Noa,²⁷ P. Reck-

1. Ind. Bl. **22**, 181.
2. U. S. P. 1228165; abst. C. A. 1917, **12**, 2268; E. P. 9966, 1913; Can. P. 169507.
3. D. R. P. 115728; abst. Wag. Jahr. 1900, **46**, II, 565.
4. U. S. P. 1098342; abst. C. A. 1914, **8**, 2611; E. P. 1790, 1910; abst. J. S. C. I. 1910, **29**, 818; E. P. 17242, 1910; abst. J. S. C. I. 1910, **29**, 1311; Kunst. 1911, **1**, 92; E. P. 10324, 10293, 18856, 1911; abst. C. A. 1912, **6**, 2828; F. P. 405881, 1909; F. P. Addn. 14829 to 405881; abst. Kunst. 1912, **2**, 235; F. P. Addn. 16020 to F. P. 439644; abst. Kunst. 1913, **3**, 96; D. R. P. 234150, 1910; abst. Kunst. 1911, **1**, 233; C. A. 1912, **6**, 1828; D. R. P. 236013, 267563, 1911; abst. Kunst. 1911, **1**, 117, 277.
5. E. P. 7954, 1893.
6. Bull. Soc. Fran. Photo. 1882, **28**, 64, 151.
7. U. S. P. 458157, 1891.
8. Bull. Soc. Phot. 1881, **27**, 151.
9. U. S. P. 260559, 1882.
10. E. P. 11836, 1913; abst. C. A. 1914, **8**, 3622.
11. E. P. 4195, 1873.
12. E. P. 111539, 1916; abst. C. A. 1918, **12**, 986. See also E. P. 1790, 1910.
13. E. P. 6210, 1913.
14. E. P. 15386, 15387, 15388, 1913; abst. C. A. 1915, **9**, 137. See also E. P. 10293, 1911; 10324, 1911; 17549, 1912; abst. C. A. 1912, **6**, 2828.
15. Magcart, U. S. P. 1342267, 1342268, 1920; J. S. C. I. 1920, **39**, 519-A.
16. Swiss P. 58686, 1911; Hung. Anm. M-3998, 1910.
17. Aust. P. 51556, 1911.
18. E. P. 12885, 1898.
19. U. S. P. 1210987; abst. C. A. 1917, **12**, 693.
20. D. R. P. 74855, 1894; abst. Zts. ang. Chem. 1894, **7**, 472; Jahr. Chem. 1894, **47**, 1134.
21. U. S. P. 916516, 1909.
22. U. S. P. 633306, 635917, 1899.
23. E. P. 20964, 1899.
24. U. S. P. 601214, 1898.
25. D. R. P. Anm. H-53770, 1911.
26. D. R. P. Anm. K-53706; abst. Kunst. 1915, **5**, 84.
27. U. S. P. 271494, 271495, 271496, 1883.

kow,¹ A. Smith,² J. Stevens,³ J. Stevens and W. Wood,⁴ L. Streeter,⁵ and A. Wyman.⁶

Embossing of celluloid is simply a mechanical process, taking advantage of the thermoplasticity of the nitrocellulose. The various phases of plastic embossing are detailed in the descriptions of W. Wood and G. Gillmore,⁷ E. Albert,⁸ G. Anders and C. Elliott,⁹ G. Bermig,¹⁰ W. Grigham,¹¹ L. Brun,¹² Capotaine & von Hertling,¹³ L. Gillrath,¹⁴ A. Hart,¹⁵ C. Heaton,¹⁶ L. Jannin,¹⁷ J. Jarvis,¹⁸ M. Krause,¹⁹ C. Mackenzie, and The Institute of Physical and Political Geography,²⁰ F. Nickerson,²¹ C. Smith,²² Soc. Vuagnat and Galet,²³ F. Warlich,²⁴ H. Widmer,²⁵ Whitehouse,²⁶ and F. Lundi and J. McMillan.²⁷

In open seam coverings manufacture, the methods of H. Dover,²⁸ T. Kays, W. Halsey,²⁹ A. Lechler,³⁰ J. Robinson,³¹ and

27. D. R. P. 124864, 1901.
1. U. S. P. 1007973, 1911; abst. C. A. 1912, **6**, 303.
2. E. P. 16247, 1899.
3. U. S. P. 626732, 630944, 630945, 1899.
4. Chem. Tech. Rep. 1885, **24**, 11, 101, U. S. P. 329093, 1885; J. A. C. S. 1884, **7**, 253.
5. U. S. P. 88228, 1899.
6. U. S. P. 892702, 1908.
7. U. S. P. 421367, 1890; Re- 11074.
8. E. P. 1503, 1885.
9. E. P. 17012, 1890.
10. D. R. P. 277049; abst. C. A. 1915, **9**, 699.
11. U. S. P. 233973, 247477, 1880.
12. F. P. 457066; F. P. Addn. 17576, Kunst. 1914, **4**, 38.
13. D. R. P. 89872, 1895; Chem. Centr. 1897, **63**, I, 1008.
14. D. R. P. 152340.
15. E. P. 5055, 1888.
16. E. P. 1395, 1888.
17. E. P. 1422, 1879; D. R. P. 14892, 1888.
18. U. S. P. 417727, 1880.
19. E. P. 6913, 1902.
20. E. P. 4457, 1904.
21. J. S. C. I. 1882, **1**, 147.
22. E. P. 1851, 1905.
23. F. P. 412710; D. R. P. 235814.
24. E. P. 376, 1891.
25. E. P. 16149, 1914.
26. Gencio. 1903, **42**, 252. Graph. Mitt. 1903, **22**, 28. Celluloid Ind. 1909, **24**, 102. Sci. Am. **14**, 16.
27. Can. P. 185724, 1918. See also F. Northrup, U. S. P. 1158830; abst. Kunst. 1919, **9**, 125.
28. E. P. 9321, 1905.
29. U. S. P. 214665, 1879.
30. U. S. P. 343523, 1886.
31. U. S. P. 607415, 607416, 1898.

American Linseed Co.,¹ are the processes primarily used.

In *lining hollow articles* with plastic, W. Eckersley,² R. Hofmann,³ F. Jones and J. Jarvis,⁴ R. Kieserling,⁵ M. Lefferts,⁶ D. Lockwood,⁷ P. Meyer,⁸ C. Jenkins,⁹ A. Parkes,¹⁰ Soc. Anon. le Carbone,¹¹ Soc. A. Olier & Co.,¹² E. Thomas and J. Bonavita,¹³ and C. Thurber,¹⁴ are applicable. Celluloid martingale, poultry and other hollow rings are manufactured according to the methods of E. Kipper¹⁵ and W. Chisholm.¹⁶

The *coating of small articles with celluloid*, either for protective purposes or having in mind enhancing their beauty or usefulness is in the hands of a large number of relatively small firms, in contradistinction to those who produce the plastic. This art is founded upon, and has been developed from the disclosures of J. Hyatt,¹⁷ Bluemel,¹⁸ E. Kipper,¹⁹ J. France,²⁰ J. McClelland,²¹ C. Thurber,²² J. Adler,²³ B. Baker,²⁴ P. Basiaux,²⁵ P. Berard,²⁶ A. Biberefeld,²⁷ E. Bluemel,²⁸ F. Capitain and J. Bernard,²⁹ Capt. Butaut,³⁰

1. E. P. 117635, 1918
2. E. P. 16921, 1898
3. D. R. P. 68361, abst. Wag. Jahr 1893, **39**, 1118
4. U. S. P. 368501, 1887
5. U. S. P. 505362, 1893
6. U. S. P. 281529, 1883
7. U. S. P. 251258, 1881
8. E. P. 3356, 1902
9. E. P. 4537, 1900
10. E. P. 865, 1867
11. F. P. 321651, 1902, abst. J. S. C. I. 1903, **22**, 298
12. F. P. 434455, 1910. See R. Harris, Can. P. 197953, 1920
13. E. P. 11063, 1900, abst. J. S. C. I. 1901, **20**, 741.
14. U. S. P. 669330, 669331, 1901.
15. U. S. P. 251258, 251259, 1881; 299802, 1884.
16. E. P. 28684, 1911
17. U. S. P. 202441, 1878, 232037, 1880, 280745, 1883. J. and I. Hyatt, U. S. P. 133229, 1872. J. Hyatt and C. Burroughs, U. S. P. 204229, 1878.
18. E. P. 17496, 1889
19. U. S. P. 333469, 1885
20. U. S. P. 328843, 1885, 430520, 1890.
21. U. S. P. 271494, 271495, 105823, 1879.
22. U. S. P. 669330, 1901
23. U. S. P. 1147066, 1915.
24. U. S. P. 1300550, abst. C. A. 1919, **13**, 1929.
25. Belg. P. 168663, 1903.
26. E. P. 639, 1858
27. D. R. P. 157383, 1902, 158612, 158613, 1904; abst. J. S. C. I. 1905, **24**, 734.
28. E. P. 17496, 1889, abst. J. S. C. I. 1890, **9**, 522
29. Dingl. Poly. 1886, **261**, 354.
30. Dingl. Poly. 1887, **266**, 480; Ann. Ind. 1887, 515.

W. Carpenter,¹ M. Chazelles,² C. Church,³ D. Cohen,⁴ E. Deiss,⁵
 W. Deutsch and C. Kanouse,⁶ J. Dunleavy,⁷ H. Engel,⁸ Finkler &
 Co.,⁹ E. Geiss,¹⁰ A. Gerspacher,¹¹ A. Gray,¹² A. Grotte and F.
 Kalous,¹³ H. Guenther,¹⁴ H. Haskell,¹⁵ W. Hentze,¹⁶ J. Herz,¹⁷ E.
 Hesse,¹⁸ E. Kempshall,¹⁹ E. Koontz,²⁰ W. Kull,²¹ N. LeBlond,²² J.
 Lewthwaite,²³ H. Lieber,²⁴ J. Lizotte,²⁵ D. Lockwood,²⁶ E. Lokesch &
 Son,²⁷ Manhattan Mfg. Co.,²⁸ Moll & Co.,²⁹ F. Olver,³⁰ G. Pifer,³¹
 A. Pope,³² Publishing, Advertising & Trading Syndicate,³³ G.
 Schreck,³⁴ Soc. Anon. "Le Carbone,"³⁵ Soc. Anon. La Cellophane,³⁶
 E. Stoeckler,³⁷ P. Thomsen, J. Luii and W. Van Dam,³⁸ R. Trested,³⁹

- 1 U. S. P. 251110, 1881, 253810
- 2 E. P. 16656, 1903
- 3 Can. P. 58402, 1897, U. S. P. 635917, 1899
- 4 E. P. 25119, 1910
- 5 Belg. P. 168839, 1903
- 6 U. S. P. 233604, 1880
- 7 E. P. 18325, 1908
- 8 E. P. 28361, 1911
- 9 C. A. 1915, **9**, 1398
- 10 Belg. P. 168839, 1903
- 11 Aust. P. 39098, 1909
- 12 Ber. 1896, **29**, 742
- 13 Aust. P. 6455, 1901
- 14 F. P. 425145, D. R. P. 235160, 1910, Swiss P. 55110, Aust. P.
 Ann. A-535, 1911, Aust. P. 54416, abst. Kunst. 1911, **1**, 276, 397, 1912, **2**,
 415, 496
- 15 U. S. P. 935603, 1909, abst. C. A. 1910, **4**, 90
- 16 E. P. 447, 1913
- 17 E. P. 758, 1897
- 18 E. P. 10708, 1911
- 19 U. S. P. 805470, 1905
- 20 U. S. P. 1148908, 1915
- 21 D. R. P. 286771, 1914, abst. C. A. 1916, **10**, 1790, Chem. Zentr.
 1915, **86**, II, 774
- 22 U. S. P. 377944, 1888
- 23 U. S. P. 103209, 1870
- 24 E. P. 11926, 1905
- 25 U. S. P. 917627, 1909
- 26 U. S. P. 205880, 1878, 251260, 1881
- 27 Aust. P. 7574, 1902
- 28 Can. P. 79696, 1903
- 29 D. R. P. 265650, 1912, abst. Kunst. 1914, **4**, 36
- 30 E. P. 4411, 1896
- 31 E. P. 28756, 1907, abst. J. S. C. I. 1908, **27**, 1220
- 32 Belg. P. 130940, 1897
- 33 Swiss P. 15442, 1897
- 34 D. R. P. 220900, abst. Wag. Jahr. 1910, **56**, II, 590
- 35 Belg. P. 163559, 1902
- 36 Swiss P. 69208, F. P. 458638, Addn. 18813, abst. Kunst. 1915, **5**, 203
- 37 U. S. P. 675451, 1901
- 38 E. P. 8880, 1913, abst. C. A. 1914, **8**, 3495
- 39 U. S. P. 234828, 1880

P. and C. Whalen,¹ M. Winkelströter,² A. Wyman,³ and W. Zeidler.⁴

Extrusion of plastic rods and tubes, compressible, seamless receptacles, capsules and ring stoppers, has reached a high degree of perfection. The art to date is exemplified in the processes of I. and J. Hyatt,⁵ W. Carpenter,⁶ J. Edson,⁷ A. Olszewski,⁸ G. Gillmore,⁹ J. Ward,¹⁰ Smith and Grasser,¹¹ F. Jones and J. Jarvis,¹² C. Thurbur,¹³ H. Barrett,¹⁴ E. Bluemel,¹⁵ Soc. Bonnard Bros.,¹⁶ A. Bowley,¹⁷ H. Braun,¹⁸ C. Cagniard,¹⁹ A. de Coetlogon,²⁰ E. Conklin,²¹ G. Converg,²² L. Corvol,²³ A. and S. de Pont,²⁴ F. Dompitet,²⁵ H. Dover,²⁶ E. Engels,²⁷ Florence Mfg. Co.,²⁸ E.erspacher,²⁹ G. Gilmore,³⁰ H. Günthner,³¹ Verein. Gelatine Gelatoid-folien und Fitterfabriken Akt.-Ges.,³² J. Hall,³³ W. Halsey,³⁴ Schenke and Engelmänn,³⁵ F. Jones and J. Jarvis,³⁶ Kleinmann-

1. E. P. 8022, 1900.
2. E. P. 20197, 1895.
3. U. S. P. 892702, 1908. See also F. Reddaway, E. P. 4235, 1901.
4. Can. P. 38397, 1892.
5. U. S. P. 133229, 1872; 204228, 1878.
6. U. S. P. 219218, 1878; 237168, 1881.
7. U. S. P. 277694, 1883; 350049, 1886.
8. U. S. P. 280659, 278667, 1883.
9. U. S. P. 655706.
10. U. S. P. 439451, 1890.
11. U. S. P. 178479, 1876.
12. U. S. P. 368501, 1887.
13. U. S. P. 669330, 669331, 1901.
14. U. S. P. 281332, 281333, 1883. E. P. 5154, 1881; D. R. P. 22835, 1882; F. P. 147499, 1882; Ital. P. 15031. See also Anthony Photo. Bull. 1890, **21**, 420; Amat. Phot. 1898, **28**, 998.
15. E. P. 17496, 1889.
16. F. P. 436895, 1911.
17. E. P. 23570, 1911.
18. E. P. 289, 1913.
19. F. P. 363012, 1906.
20. Chem. Tech. Rep. 1892, **31**, I, 127; D. R. P. 61044, 1892.
21. U. S. P. 767632, 1904.
22. F. P. 332021, 1903.
23. F. P. 447826, 1912.
24. E. P. 3652, 1895.
25. F. P. 342315, 1904.
26. E. P. 20920, 1911; abst. Kunst. 1912, **2**, 476.
27. U. S. P. 825115, 825116, 1906; D. R. P. 171704, 1905.
28. E. P. 22125, 1896.
29. E. P. 15286, 1911; abst. Kunst. 1913, **3**, 138. Aust. P. 50686.
30. U. S. P. 655706, 1900.
31. E. P. 1521, 1911.
32. E. P. 11599, 1900.
33. U. S. P. 1000598; abst. Kunst. 1913, **3**, 467.
34. U. S. P. 224682, 1880.
35. D. R. P. 96800, 1896; abst. Chem. Centr. 1898, **69**, II, 463; Wag. Jahr. 1898, **44**, 1197.
36. U. S. P. 368591, 1887.

Bros.,¹ F. Koch,² L. Kuntz and A. Rosenthal,³ W. Lindsay,⁴ Lithoid-Waarenfabr.,⁵ M. Lloyd and Curtis⁶ & Harvey,⁶ J. McComb,⁷ P. Meyer,⁸ M. Schall,⁹ O. Kausch,¹⁰ V. Montain,¹¹ J., W. and J. R. Morton,¹² S. Newton,¹³ Kohl and Wengenroth,¹⁴ Soc. A. Olier & Co.,¹⁵ H. Paschke,¹⁶ G. Petticolin,¹⁷ L. Pink,¹⁸ G. Preston,¹⁹ F. Reddaway and M. Dessau,²⁰ Rheinische Gummi and Celluloidfabrik,²¹ J. Robinson,²² W. Sargent,²³ Schenke and Engelmann,²⁴ Schreiner and Sievers,²⁵ R. Schuepphaus,²⁶ J. Snyder,²⁷ Soc. Anon. Nouvelle "L'Oyonnithie,"²⁸ Soc. Anon. Petitcollin,²⁹ B. Söhlmann,³⁰ K. Standfuss,³¹ K. Stoffels and J. Sprengel,³² Verein. Glanzstoff-Fabr.,³³ G. West,³⁴ L. Witte,³⁵ and J. Ward.³⁶

- 1 D. R. P. 225749, 1910, abst. Kunst. 1911, **1**, 35.
- 2 Aust. P. 18658, 1900; D. R. P. 138006.
- 3 E. P. 6855, 1895.
- 4 U. S. P. 1037272, 1912.
- 5 D. R. P. 68361, abst. Chem. Tech. Rep. 1893, **32**, I, 141.
- 6 E. P. 27700, 1910.
- 7 E. P. 15486, 1908.
- 8 E. P. 3356, 1902.
- 9 Kunst. 1911, **1**, 141.
- 10 Kunst. 1913, **3**, 328.
- 11 E. P. 458023, 1913.
- 12 E. P. 23511, 1899.
- 13 U. S. P. 255655, 1882.
- 14 D. R. P. 172622, abst. Wag. Jahr. 1906, **52**, II, 192, 527, Jahr. Chem. 1905-1908, II, 4348.
- 15 E. P. 435868, 1911.
- 16 U. S. P. 1131860, abst. C. A. 1915, **9**, 1227.
- 17 U. S. P. 977326, 1910; D. R. P. 211388.
- 18 E. P. 3612, 1912; Aust. Ann. A. 1216, 1912, abst. Kunst. 1912, **2**, 359.
- 19 U. S. P. 988384.
- 20 E. P. 4235, 1901.
- 21 D. R. P. 106864, 1898, abst. Chem. Centr. 1900, **61**, I, 640, Wag. Jahr. 1908, **54**, II, 539; D. R. P. Ann. R. 36273, 1912, abst. Kunst. 1913, **3**, 180.
- 22 U. S. P. 607415, 607416, 1898.
- 23 U. S. P. 270342, 1893.
- 24 D. R. P. 96800, 1898, abst. Wag. Jahr. 1898, **44**, 1197.
- 25 D. R. P. 57534, 64717, 86631, 1896, abst. Wag. Jahr. 1891, **37**, 1176, 1896, **42**, 1067, Chem. Tech. Rep. 1892, **31**, II, 87, 1896, **35**, 84, Ber. 1893, **26**, 113, 1896, **29**, 525.
- 26 J. Soc. Dyers. Col. 1907, **23**, 174, abst. J. S. C. I. 1907, **26**, 3839.
- 27 E. P. 17147, 1912.
- 28 E. P. 465570, 1913.
- 29 D. R. P. 211388, abst. Wag. Jahr. 1909, **55**, II, 554.
- 30 E. P. 10816, 1913.
- 31 D. R. P. 190091, abst. Wag. Jahr. 1907, **53**, II, 561.
- 32 E. P. 4885, 1912.
- 33 E. P. 100631, 1915.
- 34 E. P. 11598, 1913; D. R. P. 280196, 1912; abst. Kunst. 1914, **4**, 380, 384.
- 35 Aust. P. 14741, 1903.
- 36 U. S. P. 439451, 1890.

In the waterproofing of paper, cardboard and other receptacles, as pitchers, the methods of M. Lefferts¹ and A. Hollands and A. Laundry² are applicable.

Inlaying of celluloid with pigment colors³ as by the methods of F. Nickerson, M. Lefferts,⁴ E. Street,⁵ and the mounting of ornamental stones in a plastic matrix according to V. Montain,⁶ Soc. Anon. Petitcollin,⁷ and M. Brown,⁸ constitute fields of celluloid usefulness. Where metals—either as one piece or in a finely divided condition—are embedded in plastic, the directions as laid down by V. Blüthgen,⁹ R. Gaube,¹⁰ W. Gorman,¹¹ H. Günthner,¹² M. Hinzelmann,¹³ C. Josz,¹⁴ J. Kaufmann,¹⁵ M. Merle,¹⁶ L. Schwob and G. Dilette,¹⁷ Soc. des Brevets San-Claudiens en Commandite Chauvigney & Co.,¹⁸ Soc. Anon. Nouvelle l'Oyon-nithe,¹⁹ and J. Tronel²⁰ may be followed.

The *deposition of precious metals* upon a yielding base has long engaged the attention of investigators, and the incrustation of gold and silver in celluloid may be so manipulated as to produce very pleasing and useful effects. The *modus operandi* has been described by H. Barnes,²¹ C. Blacklidge,²² J. Daly,²³ A. Neubauer, R. Grotte and F. Kalous,²⁴ L. Schwob and G. Dilette,²⁵

1. U. S. P. 219279, 1879.
2. E. P. 29052, 1906.
3. J. S. C. I. 1882, **1**, 147.
4. U. S. P. 235954, 1880.
5. U. S. P. 730514.
6. F. P. 467709, 1914.
7. F. P. 361391, 1905.
8. U. S. P. 714447, 1902.
9. E. P. 4589, 1883. In this connection see Cosmos, 1909, **59**, 614.
10. O. Parkert, Kunst. 1919, **9**, 97.
11. F. P. 362424, 1906.
12. U. S. P. 1008029, 1911; abst. Kunst. 1912, **2**, 135.
13. F. P. 425145, 1911.
14. E. P. 7386, 1897.
15. E. P. 11344, 1889.
16. U. S. P. 1024203, 1912; abst. C. A. 1912, **6**, 1663; F. P. 428886; abst. Kunst. 1911, **1**, 457; D. R. P. 240501, 1910; Addn. 240904, 1911; abst. C. A. 1912, **6**, 2150.
17. F. P. 448615, 1911.
18. F. P. 359001, 364559; abst. J. S. C. I. 1906, **25**, 323.
19. F. P. 476934, 1914.
20. F. P. 458002, 1913; abst. C. A. 1914, **8**, 2230.
21. E. P. 11717, 1913.
22. U. S. P. 348183, 1886.
23. U. S. P. 799218, 1905.
24. U. S. P. 306468, 1884.
25. F. P. 304804, 1900; abst. Mon. Sci. 1902, **58**, 44; D. R. P. 139447;

Soc. Anon. Petitcollin,¹ N. Hart and R. Bacon,² and Compagnie française de Celluloid.³ The ornamenting processes of F. Pfanzelter,⁴ A. Unruh,⁵ H. Fritsch⁶ and J. Kestner,⁷ are interesting in this connection.

In pyroxylin plastic (as distinguished from cellulose nitrate) adhesives, cements, lacquers and similar flowable solutions, advancement has been made in many directions. This progress is revealed in the methods proposed by⁸ "Ago" Lederkitt Industrie-Ges.,⁹ W. Alber,¹⁰ Andés,¹¹ F. Annison,¹² D. Bachrach,¹³ A. Biltz,¹⁴ M. Bottler,¹⁵ J. Bourumneau,¹⁶ T. Brecht,¹⁷ J. Bernard,¹⁸ A. Chaumat,¹⁹ J. Cheetham and T. Southworth,²⁰ Cleminson Electric Lamp

- abst. Fort. der Elektrotechnik, 1903, **17**, 452, Bayer. Ind. Gewerbl. 1904, **36**, 143.
25. F. P. 304559, 1906, abst. J. S. C. I. 1906, **25**, 906.
 1. F. P. 424677, 1910.
 2. E. P. 4874, 1880. See also Cosmos, 1908, **59**, 614.
 3. U. S. P. 370546; F. P. 177524; Belg. P. 74802; Ital. P. Sept. 30, 1880; Aust. Hung. P. Nov. 4, 1880; Span. P. Nov. 13, 1880; abst. Mon. Sci. 1887, **29**, 508.
 4. E. P. 24721, 1899.
 5. Kunst. 1913, **3**, 403. In this connection see D. R. P. 120240, 1901; abst. Wag. Jahr. 1901, **47**, II, 610. See also Williams, Australian P. Appl. 4216, 1905.
 6. E. P. 11836, 1913.
 7. D. R. P. 155117; abst. Wag. Jahr. 1904, **50**, II, 512, Jahr. Chem. 1904, **57**, 1168.
 8. Photo. Corres. 1890, **27**, 580. Mon. Phot. 1890, **29**, 170. Bayer. Ind. Gewerbl. 1891, **23**, 489, 1892, **24**, 356, 1894, **26**, 392. Amat. Photog. 1893, **18**, 111; 1897, **26**, 306; 1902, **36**, 460; 1910, **51**, 347, 1912, **55**, 323, 347, 490; 1912, **56**, 75; 1915, **61**, 187. Am. J. Phot. 1892, **13**, 84. Photography, 1894, **6**, 320, 1900, **12**, 473, 1901, **13**, 315, 865, 1915, **40**, 396. Anthony Photo. Bull. 1894, **25**, 353. Gummi. Ztg. 1894, No. II. Heliost. Illustre, 1894-1895, **5**, 285. Amer. Apoth. Ztg. 1897, **18**, 87, 1901, **22**, 121. Erfind. Erfahr. 1901, **28**, 350. Schweizer Graph. Mitth. 1902, No. 24. Photo. Monthly, 1908, **15**, 123. Dental Cosmos, 1913, **55**, 752. Brit. J. Photog. 1892, **39**, 115. Jahr. Phot. 1914, **28**, 504. Ullman, **5**, 337. D. R. P. 103042; Baugew. Z. 1899, **31**, 246. D. R. P. 283304, 1915; abst. Zts. Chem. Ind. Koll. 1915, **16**, 186.
 9. E. P. 4016, 1913; D. R. P. 276661, 1914; abst. Zts. Chem. Ind. Koll. 1914, **15**, 205; Chem. Zentr. 1914, **85**, II, 447, Kunst. 1914, **4**, 393; C. A. 1915, **9**, 714.
 10. E. P. 7020, 1888.
 11. Farben. Ztg. 1919, **20**, 999; abst. Chem. Zentr. 1919, **90**, 194; J. S. C. I. 1919, **38**, 833-A.
 12. Can. P. 46932, 1894.
 13. U. S. P. 692102, 1901; abst. Mon. Sci. 1902, **58**, 77, J. S. C. I. 1902, **21**, 366.
 14. E. P. 18744, 1901.
 15. Kunst. 1913, **3**, 461.
 16. E. P. 24901, 1894.
 17. U. S. P. 299514, 1884.
 18. Chem. Tech. Rep. 1886, **25**, II, 167.
 19. U. S. P. 1062222; F. P. 429841; abst. J. S. C. I. 1911, **30**, 1308;

Attachment and W. King,¹ K. Collins,² F. Cantu, G. Miglioretti and G. Maffei,³ Compagnie Francaise du Celluloid,⁴ L. Crozat,⁵ M. and A. Dessau,⁶ T. Didier,⁷ H. Dittmar,⁸ R. Dockree,⁹ D. Oerr,¹⁰ I. Drummond,¹¹ W. Field,¹² A. Finkler,¹³ F. Forster, G. Rockwood,¹⁴ J. France,¹⁵ J. and B. Galay,¹⁶ G. Gawlich,¹⁷ Gembicki,¹⁸ E. Georgii,¹⁹ O. Gottschalk,²⁰ F. Greening,²¹ R. Grüter,²² A. Haase,²³ J. Hackenberg,²⁴ R. Halben,²⁵ D. Halluin,²⁶ A. Hart,²⁷ Heberlein & Co.,²⁸ F. Hesse,²⁹ S. Hobday,³⁰ P. Horn,³¹ T. Hughes,³² P. Hunäus,³³ G. Jarman and J. Taylor,³⁴ H. Jerne,³⁵ A. Junghans,³⁶ Kausch,³⁷ J. Kessler,³⁸ F. Klatte and A. Rollett,³⁹ H. Koller,⁴⁰ 1913, **32**, 653.

20. E. P. 653, 1887.
1. E. P. 6600, 1904; abst. J. S. C. I. 1905, **24**, 198.
2. U. S. P. 405874, 1889.
3. E. P. 1160, 1901.
4. E. P. 9874, 1886.
5. E. P. 2953, 1864.
6. E. P. 7848, 1904.
7. E. P. 22245, 1904; abst. J. S. C. I. 1905, **24**, 855; F. P. 336970, 1903; abst. J. S. C. I. 1904, **23**, 453.
8. E. P. 2064, 1911.
9. E. P. 15841, 1909.
10. Am. Apoth. Ztg. 1900, **21**, 121.
11. U. S. P. 248413, 1881.
12. E. P. 422195, 434330, 1890; 498162, 1893; E. P. 15771, 1887.
13. E. P. 8126, 1914; abst. J. S. C. I. 1914, **33**, 1215; C. A. 1915, **9**, 1398.
14. E. P. 6501, 1893.
15. U. S. P. 481485, 1892.
16. E. P. 1715, 1909; abst. J. S. C. I. 1909, **28**, 163.
17. E. P. 16199, 1909.
18. D. R. P. 130938; abst. Wag. Jahr. 1902, **48**, II, 594.
19. D. R. P. 224832; abst. Wag. Jahr. 1910, **56**, II, 536.
20. D. R. P. 233474; abst. C. A. 1912, **6**, 1824; Zts. ang. Chem. 1911, **24**, 1007; Wag. Jahr. 1911, **57**, II, 535.
21. E. P. 2059, 1875.
22. U. S. P. 1195673, 1916.
23. D. R. P. 158928, abst. Wag. Jahr. 1905, **51**, I, 113.
24. U. S. P. 699516, 1902.
25. D. R. P. 166325.
26. E. P. 2515, 1876.
27. E. P. 11340, 1909; 18606, 18607, 1910; abst. J. S. C. I. 1911, **30**, 1446, 1448; F. P. 433013, 1911; abst. J. S. C. I. 1911, **30**, 1448.
28. E. P. 3861, 1901; abst. J. S. C. I. 1901, **20**, 710.
29. U. S. P. 1065684, 1913. Aust. P. 58471; abst. Kunst. 1913, **3**, 474.
30. E. P. 10110, 1904.
31. F. P. 385153, 1907; abst. J. S. C. I. 1908, **27**, 579.
32. E. P. 8513, 1889.
33. D. R. P. 124863; abst. Wag. Jahr. 1901, **47**, II, 609.
34. E. P. 23967, 1911.
35. E. P. 2145, 1911; abst. J. S. C. I. 1912, **31**, 250; C. A. 1912, **6**, 1941.
36. U. S. P. 1099378; abst. C. A. 1914, **8**, 2825.
37. Kunst. 1913, **3**, 63, 89, 127.
38. U. S. P. 922596, 1909; abst. J. S. C. I. 1909, **28**, 718; Kunst. 1911,

L. Kraus,¹ L. Kurz,² W. Kuwert and E. Buschler,³ LeRoy,⁴
 E. and W. Leuscher,⁵ H. Ligny,⁶ L. Lilienfeld,⁷ H. Linnekogel,⁸
 C. Lütgenan and T. Schrens,⁹ E. Maalouf,¹⁰ J. MacIntosh and G.
 Rhodes,¹¹ M. Merle,¹² P. Marino,¹³ K. McElroy and C. Ellis,¹⁴
 S. von Medveczky,¹⁵ Mertens & Co., H. Jerosch and H. Lyncke,¹⁶
 F. Meyer,¹⁷ W. Millspaugh,¹⁸ J. Neupert,¹⁹ M. Newton,²⁰ E. Noa,²¹
 F. Oliver,²² L. Paget,²³ J. Peiffer, W. MacCarty and Perigord de
 Sagan,²⁴ J. Perl,²⁵ L. Pink,²⁶ F. Rampichini,²⁷ Rheinische Gummi
 and Celluloid Fabrik,²⁸ A. Rollason,²⁹ P. Samin,³⁰ M. Schall,³¹
 L. Schöffner,³² Y. Schwartz,³³ Self-Developing Plate Co. and T.

1, 413

- 39 U. S. P. 1241738, abstr. C. A. 1918, **12**, 231.
- 40 E. P. 26072, 1904
- 1 D. R. P. Anm. K-52040, 1912, abstr. Kunst. 1913, **3**, 240.
- 2 U. S. P. 982370, 1911
- 3 Ber. 1896, **23**, 255
- 4 Bull. Soc. Rouen, 1897, **25**, 386
- 5 E. P. 18684, 1902, abstr. J. S. C. I. 1903, **22**, 211
- 6 F. P. 386846, 1907, abstr. J. S. C. I. 1908, **27**, 828
- 7 E. P. 28210, 1912
- 8 U. S. P. 980807, D. R. P. 234299, Swiss P. 52116; Aust. P. 5005 ,
 1911, abstr. Kunst. 1914, **4**, 285
- 9 E. P. 18586, 1899
- 10 F. P. Addn. 6963, 1906, to 360545.
- 11 E. P. 734, 1859
- 12 F. P. 448651, abstr. Kunst. 1913, **3**, 217
- 13 E. P. 30602, 1909
- 14 U. S. P. 914300, 1909
- 15 E. P. 27283, 1910
- 16 E. P. 18493, 1908, abstr. J. S. C. I. 1909, **28**, 1157.
- 17 Can. P. 131808, 1911.
- 18 E. P. 7042, 1910
- 19 Chem. Tech. Rep. 1887, **26**, II, 150.
- 20 U. S. P. 128416, 1872
- 21 F. P. 419061; abstr. Kunst. 1911, **1**, 91, 1913, **3**, 302, 1914, **4**, 269;
 Belg. P. 227910, 1910.
- 22 E. P. 17747, 1894, 10103, 1896
- 23 U. S. P. 494792; E. P. 22137, 1893.
- 24 E. P. 5255, 1878
- 25 E. P. 3557, 21455, 1893. In this connection see P. Ridel, E. P.
 21409, 1893.
- 26 Aust. P. 57971; abstr. Kunst. 1913, **3**, 256
- 27 U. S. P. 1089960, 1914 E. P. 4253, 1911; abstr. J. S. C. I. 1912,
31, 240; C. A. 1912, **6**, 2173. E. P. 7086, 1913 D. R. P. 253984, 1911; abstr.
 Kunst. 1912, **2**, 420; 1913, **3**, 50, Wag. Jahr. 1912, **58**, II, 621; C. A. 1913,
7, 900
- 28 D. R. P. 106864, 142454, 1901, abstr. Wag. Jahr. 1900, **46**, II, 505,
 570.
- 29 E. P. 2143, 1864.
- 30 D. R. P. 172285, 1903; Addn. to D. R. P. 162444, 1902.
- 31 Kunst. 1911, **1**, 201, 911; abstr. Wag. Jahr. 1911, **57**, II, 534.
- 32 E. P. 7508, 1897.
- 33 E. P. 9992, 1902; abstr. J. S. C. I. 1903, **22**, 572.

Bolas,¹ F. Simeons and J. Mainzer,² P. Simoulin,³ E. Sperry,⁴ H. Tas and J. David,⁵ F. Tiller and O. Benzinger and R. Meyer,⁶ H. Traum,⁷ W. Thompson,⁸ Triplex Safety Glass Co.,⁹ Towndrow,¹⁰ Andreas,¹¹ United Fast Color Eyelet Co.,¹² E. Wade,¹³ A. Zimmer,¹⁴ and E. I. duPont de Nemours & Co.¹⁵

In addition to the general processes of pyroxylin plastic manufacture previously touched upon¹⁶ are the more or less specific refinements of J. West and C. Whipple,¹⁷ R. Triplett,¹⁸ F. Seelau,¹⁹ A. Ryder,²⁰ H. Roscher,²¹ W. Richardson,²² J. Peabody,²³ Chemal,²⁴ MacClelland,²⁵ J. Ludwig,²⁶ S. Korper,²⁷ Kohl & Wengeroth,²⁸ A. de Jong,²⁹ P. Hunaeus,³⁰ Hammer & Vorsak,³¹ T. Guilford,³² W. Eckersley,³³ O. Eberhard,³⁴ J. Cutting, S. Crocker,³⁵

1. E. P. 21880, 1907.
2. E. P. 14185, 1907.
3. E. P. 9910, 1887. See E. Steele, E. P. 9934, 1901.
4. E. P. 5569, 1900.
5. E. P. 22528, 1907. See also Nürnberger Zelluloidwarenfabrik, Gebr. Wolff, D. R. P. Anm. N-16823; abst. Kunst. 1919, **9**, 210.
6. E. P. 18416, 1907.
7. E. P. 359, 1899.
8. E. P. 26893, 1905; abst. J. S. C. I. 1906, **25**, 1096.
9. E. P. 15386, 1913.
10. Amer. Mach. 1903, **26**, 589.
11. Uhland's W. T. 1892, **6**, 447; Met. Arch. **18**, 403.
12. E. P. 2037, 1902.
13. E. P. 11520, 1912.
14. E. P. 24006, 1909; 6519, 1910. Cf. W. Kingston, U. S. P. 1164821; abst. Kunst. 1919, **9**, 157.
15. Can. P. 179609.
16. Poly. Notiz. 1887, **34**, 249. Anthony Photo. Bull. 1890, **21**, 420. Bull. de la Soc. Fran. de Phot. 1890, II, **6**, 68. Bull. de la Soc. Fran. de Phot. 1891, II, **7**, 271. Z. Dreschsler, 1892, **15**, 206. Dingl. Poly. 1893, **290**, 277. Amat. Phot. 1898, **28**, 908. Pharm. Centr. 1899, **40**, 63. Photog. 1902, **14**, 415. Z. Dreschsler, 1905, **28**, 175. Cosmos, 1912, **66**, 252. Kunst. 1913, **3**, 77. C. A. 1915, **9**, 699. Celluloid, **8**, 27. Wag. Jahr. 1900, **46**, II, 566. D. R. P. Anm. K-43623, 1910.
17. U. S. P. 508494.
18. U. S. P. 255355, 1882.
19. Belg. P. 212052.
20. E. P. 13188, 1905.
21. E. P. 27683, 1911.
22. Can. P. 35821, 1891.
23. U. S. P. 517011, 1894.
24. F. P. 307951, 1901.
25. F. P. 86546, 1869.
26. D. R. P. 197153.
27. U. S. P. 847012, 1907.
28. D. R. P. 172622, 1903; abst. Wag. Jahr. 1906, **52**, II, 527.
29. E. P. 14948, 1895.
30. D. R. P. 235400.
31. D. R. P. Anm. A-6710, 1904.
32. U. S. P. 256476, 1882.
33. Swiss P. 64048; E. P. 1081, 1913; U. S. P. 1083275; Aust. P. 64651;

, W. Bray,¹ and S. Creasey,² which aim at the attainment of specific results, or for producing a predetermined result or effect.

In the manufacture and preservation of mathematical, astronomical and other scientific and philosophical instruments, xylonite and celluloid find extensive employment. This is apparent from the diversity of uses in this respect as indicated in the methods proposed by R. Boyd,³ W. Brecknell,⁴ V. Copland,⁵ H. Crane,⁶ S. Crocker,⁷ P. Feraud,⁸ C. Galle,⁹ P. Germain,¹⁰ I. Drummond,¹¹ C. Harper and J. Moody,¹² W. Haseler,¹³ W. Holt,¹⁴ T. Houghton,¹⁵ G. Huber,¹⁶ Jordan,¹⁷ Nürnberger Zelluloidwarenfabrik Gebrüder Wolff,¹⁸ E. Neron,¹⁹ J. Rindsberg,²⁰ M. Taussig,²¹ and the slide rule described by A. Faber.²²

The process of W. Carpenter for the manufacture of *celluloid penholders* in 1879²³ was followed by those of F. Furman,²⁴ C. Bosworth,²⁵ L. Hopkins,²⁶ E. Kempshall,²⁷ W. Sharp,²⁸ and G. Walker,²⁹ and are designed to simulate in appearance quill hold-

abst. Kunst 1914, **4**, 274.

34. U. S. P. 31657, 1861; E. P. 1638, 1854.

35. E. P. 23384, 1901.

1. E. P. 13937, 1909.

2. E. P. 5646, 1912. W. Schlesinger, U. S. P. 1342767, abst. C. A. 1920, **14**, 2401; luminous watch dial

3. U. S. P. 529892, 1894.

4. E. P. 24401, 1914.

5. U. S. P. 680227, 1901.

6. U. S. P. 891819, 1908.

7. E. P. 23384, 1901.

8. E. P. 3327, 1911.

9. U. S. P. 443205, 1890.

10. Belg. P. 181747, 1905.

11. U. S. P. 248413, 1881; abst. J. A. C. S. 1881, **3**, 168.

12. E. P. 24324, 1912.

13. E. P. 10568, 1905.

14. E. P. 12971, 1913.

15. U. S. P. 857462, 1907.

16. U. S. P. 617747, 1899.

17. Dingl. Poly. 1888, **268**, 429.

18. D. R. P. 266617, 1912; abst. Kunst 1914, **4**, 16.

19. U. S. P. 800815, 1905.

20. U. S. P. 838750, 1906. See W. Dodsworth, U. S. P. 763091, 1900.

21. E. P. 27756, 1904.

22. E. P. 10753, 1913. See also Photographische Ind. 1912, 85.

23. U. S. P. 219218, 1879.

24. U. S. P. 282451, 1883.

25. E. P. 24675, 1897.

26. U. S. P. 401435, 1889.

27. Pap. Ztg. 1898, I, 803.

28. E. P. 772, 1890.

29. E. P. 11923, 1913.

ers, either natural or colored. The methods of C. Bosworth,¹ F. Colburn,² Degroide,³ Erste Prager Celluloid Kammwaren Fabrik Brüder Lux,⁴ N. Gargano and W. White,⁵ F. Hutchinson,⁶ E. Kempshall,⁷ A. Stiegler,⁸ E. Wade,⁹ and G. Walker,¹⁰ disclose methods for the formation of toothpicks and pens of celluloid.¹¹ Special inks¹² for writing and printing on celluloid have been evolved, and are described by A. Graf,¹³ M. Lefferts and J. Stevens,¹⁴ J. McCloskey and C. Farwell,^{15,16} W. Kuwert and C. Buschler,^{17,18,19}

In the *smoking pipe industry*, cigar-holder and pipe tips, celluloid has been employed to a limited extent, and fashioned according to the inventions of W. Demuth,²⁰ J. Hartstock,²¹ J. Kaldenberg,²² W. Kaufman,²³ and A. Woods.²⁴ Celluloid for knife and fork handles has in many instances replaced horn, wood, tortoise shell and ivory, advantages being greater elasticity and durability. The processes of A. Allen,²⁵ A. Arbenz,²⁶ L. Beals and P. Thomas,²⁷ A. Feist & Co.,²⁸ L. Gaylor,²⁹ H. Hart,³⁰ G. Hast-

1. E. P. 24675, 1897.
2. U. S. P. 482208, 1892.
3. F. P. 208599, 1900, abst. Mon. Sci. 1901, **57**, 57.
4. F. P. 416213, 1910.
5. E. P. 26035, 1903.
6. E. P. 7491, 1907.
7. U. S. P. 508730, 1898.
8. E. P. 5636, 1895.
9. E. P. 11520, 1912.
10. E. P. 11923, 1913.
11. J. S. C. I. 1892, **11**, 1044; Photographic Works, 1893, **2**, 54. See also Erfind. Erfahr. 1893, **20**, 610.
12. Eder's Jahr. 1897, 500. Pharm. Centr. 1901, **42**, 661; Seifenfabr. 1901, **21**, 745. Cosmos, 1907, **56**, 138.
13. Swiss P. 62354, 1913; abst. C. A. 1914, **8**, 2270.
14. U. S. P. 380654, 1888.
15. Phot. Chron. 1902, 211.
16. U. S. P. 422330, 1890.
17. Erfind. Erfahr. 1896, **23**, 304.
18. Rev. Gen. Pharm. **10**, 727; abst. Year Book of Pharmacy, 1903, 333.
19. Gewerbl. Württemberg, 1901, **53**, 277.
20. U. S. P. 266582, 1882.
21. U. S. P. 534505, 1895.
22. U. S. P. 265613, 1882.
23. U. S. P. 901915, 1908.
24. U. S. P. 780465, 1905.
25. U. S. P. 739371, 1903.
26. U. S. P. 903160, 1908.
27. U. S. P. 222229, 1879.
28. Swiss P. 62303; abst. Kunst. 1914, **4**, 156.
29. U. S. P. 794934, 1905.
30. U. S. P. 948727, 1910.

ings,¹ I. Hyatt and J. Hyatt, Jr.,² M. Lefferts,³ E. Longdon,⁴ G. McVey,⁵ G. Miller,⁶ E. Miltner,⁷ J. Ohlsson,⁸ F. Oliver,⁹ A. Pauls,¹⁰ T. Ransom,¹¹ and J. Watts,¹² are indicative of progress in this direction.

For many years paper cartridges have been coated with pegamoid and other forms of nitrocellulose to waterproof and preserve them.¹³ The technics of formation of such cases are contained in the descriptions of A. Barrallon,¹⁴ E. Bergerat,¹⁵ L. de Froideville,¹⁶ C. Claessen,¹⁷ D. Hickie and G. Beutner,¹⁸ H. Holt,¹⁹ J. Lower,²⁰ W. Routledge,²¹ F. Oliver,²² A. Boulton,²³ and F. Timmel.²⁴ Matches,²⁵ primers²⁶ and igniting pills on pocket-lighters have also provided use for celluloid.²⁷ The process of F. Prince goes back to 1855.²⁸ As an admixture with abrasive material for emery wheels and as attrition sheets celluloid has a limited use, and has not always been successful, notwithstanding the inventions of I. Brown and A. Sanborn,²⁹ J. and I. Hyatt,³⁰ C.

1. U. S. P. 803161, 1905.
2. U. S. P. 35652, 1862.
3. U. S. P. 235954, 1880.
4. U. S. P. 746348, 1903.
5. U. S. P. 901253, 1908.
6. U. S. P. 631546, 1899.
7. U. S. P. 1052082, 1913.
8. E. P. 10064, 1909, 24471, 1911.
9. E. P. 10103, 1896.
10. U. S. P. 509762, 1893.
11. U. S. P. 199743, 1878.
12. E. P. 12732, 1890.
13. Waffenschm., **4**, 37. D. R. P. 85235, 1894, abstr. *Wag. Jahr* 1896, **42**, 1068. F. P. 189398, 1888. W. Allan, *Arms and Explos.* 1894, **2**, 105.
14. E. P. 14681, 1902.
15. E. P. 7324, 1892, Ber. 1893, **26**, 428.
16. E. P. 1275, 1874.
17. E. P. 12346, 1913.
18. E. P. 12649, 1894; abstr. *Arms and Expl.* 1895, **3**, 178.
19. E. P. 23320, 1913, Addn. to E. P. 18100, 1912.
20. U. S. P. 535394, 1895.
21. E. P. 5907, 1913.
22. E. P. 17001, 1894.
23. E. P. 17020, 1889.
24. E. P. 2952, 1903, abstr. *Arms and Expl.* 1903, **11**, 81.
25. E. P. 5907, 1913.
26. E. P. 5508, 1886.
27. D. R. P. 72223; abstr. *Chem. Tech. Rep.* 1894, **33**, I, 242.
28. E. P. 33, 173, 1855. See C. Chilowsky, E. P. 132008, 1918 (incendiary shell, comprising the use of celluloid). The U. S. P. 1325618; E. P. 131644, 1918 (abstr. J. S. C. I. 1919, **38**, 796-A; *ibid.* **39**, 174-A) of A. Chanard is similar.
29. U. S. P. 187593, 1877.
30. U. S. P. 165234.

King,¹ H. Stempel,² R. Rathmann,³ and E. Culmant.⁴ The T. Kelly filler for rubber and celluloid⁵ was disclosed in 1911.

In vehicle manufacture,⁶ moulding gear cases,⁶ tire rims,⁷ mud guards, pump clips,⁸ handle bars, vehicle frame coatings,⁹ encased frame tubes,¹⁰ cycle handle grips,¹¹ brakes and levers, covered cranks,¹² and velocipede handles,¹³ pyroxylin has found a great variety of uses. Details are specified¹⁴ in the patents of R. Alpe and F. Moore,¹⁵ C., F. and E. Bluemel,¹⁶ T. Bourne,¹⁷ H. Butts,¹⁸ J. Clegg,¹⁹ H. Collins and N. Tailby,²⁰ R. Day,²¹ M. and A. Dessau,²² A. and S. De Pont,²³ H. Dover,²⁴ J. Dring, J. Trigwell and E. Bowden's Patents Syndicate, Ltd.,²⁵ Florence Manufacturing Co.,²⁶ D. Forbes and J. Weymouth,²⁷ R. Hearnden,²⁸ J. Hodgson,²⁹ P. Hunacus,³⁰ H. Lamoisse,³¹ K. Lengfellner,³² F. Matthews,³³ J.

1. U. S. P. 1235325; abst. C. A. 1917, **11**, 2605.
2. U. S. P. 1208688, 1916, abst. C. A. 1917, **12**, 280.
3. E. P. 15486, 1906.
4. F. P. 399122, 1908.
5. E. P. 5712, 1911.
6. H. Dover, E. P. 18561, 1896.
7. D. Forbes and J. Weymouth, E. P. 18864, 1896.
8. H. Dover and P. Phipps, E. P. 20143, 20948, 1897.
9. A. Pope, E. P. 22413, 22414, 22415, 22416, 1897.
10. H. Lamoisse, E. P. 30357, 1897.
11. H. Dover, E. P. 15766, 1903. J. Wilkinson and J. Fitzgerald, E. P. 20984, 1894.
12. C. Pugh and Rudge-Whitworth, Ltd., E. P. 25446, 1907.
13. P. Hunacus, D. R. P. 171657, 1905.
14. Ind. Rubber World 1897, **14**, 302; Neues Erfind. Unt. Erfahr. 1907, **34**, 260. Popular Mechanics, 1917, 782. Diamant, **34**, 579, 618; abst. C. A. 1912, **6**, 2506.
15. E. P. 12895, 1914; abst. C. A. 1915, **9**, 3120.
16. U. S. P. 703228, 1902.
17. E. P. 27048, 1911.
18. E. P. 102609, 1916; abst. C. A. 1917, **12**, 1041.
19. E. P. 13171, 1900.
20. E. P. 9081, 1914.
21. U. S. P. 529368, 1894.
22. E. P. 7848, 1904.
23. E. P. 3652, 1895.
24. U. S. P. 586840; E. P. 18561, 1896; 20143, 20948, 1897; 13560, 1898; 10286, 1901; 15766, 1903.
25. E. P. 24932, 1903.
26. E. P. 19329, 1896.
27. E. P. 18864, 1896.
28. U. S. P. 618939, 1899.
29. U. S. P. 581287, 1897.
30. D. R. P. 171657.
31. E. P. 30357, 1897.
32. Swiss P. 43477, 1908. E. P. 25276, 1908; abst. C. A. 1909, **3**, 3013; J. S. C. I. 1909, **28**, 946. D. R. P. 206223, 1907; abst. Wag. Jahr.
33. F. Matthews, E. P. 20984, 1894.

Moore and The Jesmond Cycle Company, Ltd.,¹ W. Moore and A. Shardlow & Co.,² A. Pope,³ J. Price,⁴ C. Pugh and Rudge-Whitworth, Ltd.,⁵ P. Raczek,⁶ J. Robinson,^{7,8} E. Smith,⁹ A. Spalding & Bros.,¹⁰ A. Thomas,¹¹ C. Wheeler,¹² Williams & Caywood,¹³ and F. Wilson.¹⁴

Celluloid in Electrical Industries. Pyroxylin plastics are extensively employed¹⁵ in the domain of electricity. The celluloid accumulators and cells as prepared by P. Ribbe,¹⁶ C. Riordon,¹⁷ G. Philippart,¹⁸ H. d'Arnoult,¹⁹ Aron,²⁰ Raclot,²¹ D. Davis,^{22,23} H. Dey,²⁴ F. Feldkamp,²⁵ J. Fontaine,²⁶ C. Hoepfner,²⁷ G. Huebner,^{28,29} T. Jones,³⁰ T. Jones and W. Tasker,³¹ V. de Kara-

1909, **55**, 11, 555, C. A. 1909, **3**, 1938

33. E. P. 16278, 1911.

1. E. P. 1587, 1901.

2. E. P. 21562, 1911.

3. E. P. 22414, 22415, 1897.

4. E. P. 19602, 1893.

5. E. P. 25446, 26263, 1907.

6. U. S. P. 604216, 1898.

7. U. S. P. 607416, 1898.

8. U. S. P. 607415, 1898.

9. E. P. 22161, 1897.

10. E. P. 9353, 1897.

11. U. S. P. 1034534, 1912.

12. E. P. 573, 1911.

13. U. S. P. 552567, 1896.

14. F. Wilson, E. P. 27578, 1911. See J. Schlen, D. R. P. 307825; abst. Kunst 1919, **9**, 11.

15. Anon Electrician, 1916, **76**, 627; abst. C. A. 1916, **10**, 858. Gewerbl. Wurt. 1891, **43**, 191. Electrical Rev. **42**, 586, Zts. Elektro Technik. 1903, 375, Fort der Elektrotech. 1903, **17**, 209. Kunst 1914, **4**, 60.

16. E. P. 20656, 1897. D. R. P. 86623, Addn. to 75349. Electrochem. Anz. 1898, **15**, 141. D. R. P. 89515, 98274. E. P. 5506, 1896. U. S. P. 595580; abst. Fortschr. Elektrotech. 1897, **11**, 238.

17. E. P. 8231, 1897.

18. E. P. 1194, 1897.

19. U. S. P. 682899, **19**, P. 301522, 1900; Centr. f. Accum. u. Elem. 1901, **2**, 320.

20. D. R. P. 21957, 1882.

21. Belg. P. 252249, 1912.

22. E. P. 5349, 1885. See also E. P. 11933, 1884.

23. E. P. 5349, 1885.

24. Horseless Age, 1900, **12**, 369.

25. U. S. P. 749855.

26. D. R. P. 116412.

27. E. P. 19375, 1891.

28. E. P. 8011, 1895; abst. Wag. Jahr. 1895, **41**, 288.

29. D. R. P. 82111, 82112; abst. Wag. Jahr. 1895, **41**, 288.

30. E. P. 5045, 11454, 1885.

31. E. P. 8627, 1885; 11101, 1886.

vodine,¹ G. Philippart,² Ponteaux & Wolff,³ H. Porter,⁴ A. Schanschieff,⁵ C. Riordon,⁶ E. Sperry,⁷ S. Stefano,⁸ C. Theryc and A. Oblasser,⁹ I. Timmis,¹⁰ A. Fribe,¹¹ and Winkler, Crompton and Howell¹² are representative of advances made.

In celluloid compositions applicable as electric insulating and acid-proof materials, as protection for metal boxes for switches and wall plugs, galvanic metal reproductions of articles of the plastic art; battery jars, the methods covering this branch are shown in the patents and publications of R. Abrey,¹³ E. Ali-Cohen,¹⁴ M. Allen,¹⁵ C. Backmann,¹⁶ L. Baringer,¹⁷ L. Basset,¹⁸ C. Bensinger,¹⁹ L. Bethisy, E. Vignes and L. Fouchard,²⁰ J. Billwiller and P. Karrer,²¹ S. Brown,²² M. de Chazelles,²³ T. Midgley,²⁴ H. Dover,²⁵ E. Street,²⁶ J. Fleming,²⁷ G. Fretard,²⁸ H. Günthner,²⁹ D. Hawes,³⁰ C. Hearson,³¹ W. Henley and D. Spill,³²

1. E. P. 2493, 1911.
2. D. R. P. 49356, 1889. E. P. 1194, 1897; *Jahr. Electrochemie* 1908, **5**, 284.
3. F. P. 304112.
4. U. S. P. 792612.
5. E. P. 5202, 1885.
6. E. P. 231, 1897; *Jahr. d'Electrochemie*, 1898, **5**, 284.
7. U. S. P. 646922, 646923, 649003; *abst. Centr. Akt.* 1900, I, 193.
8. E. P. 22710, 1899.
9. U. S. P. 502643, 1893; E. P. 19242, 20598, 1892; F. P. 221204, 1892; *Swiss P.* 6030, 1892; *Belg. P.* 101872, 1892; *Ital. P.* 32886; *Span. P.* 13906, 1892.
10. E. P. 10604, 1888.
11. E. P. 2073, 1884. J. Ahlgren, *Can. P.* 194321, 1919.
12. *Dingl. Poly.* 1893, **290**, 277. See also *Iron Age*, 1887, **24**, 26.
13. E. P. 18417, 1901.
14. E. P. 5279, 1908.
15. U. S. P. 337472, *abst. Kunst.* 1913, **3**, 390.
16. E. P. 14062, 1909.
17. U. S. P. 1009630; E. P. 19035, 1905; *abst. J. S. C. I.* 1906, **25**, 700; 1911, **30**, 1459.
18. E. P. 22236, 1908; *abst. J. S. C. I.* 1909, **28**, 1206.
19. U. S. P. 688222, 688223, 1901; 1023612, 1912; E. P. 21834, 1901; 26838, 1902.
20. E. P. 11397, 1907; *abst. J. S. C. I.* 1908, **27**, 640.
21. E. P. 28434, 1904.
22. E. P. 1157, 1911.
23. E. P. 16656, 1903.
24. E. P. 118595, 1919.
25. U. S. P. 699458, 699459, 1902. E. P. 5427, 1901; 1967, 1902.
26. U. S. P. 739514. See also W. Clark & G. Rupley, U. S. P. 687517, 687518, 1901.
27. U. S. P. 319084, 1885. E. P. 6647, 1884. Reference is made to U. S. P. 284289.
28. E. P. 5825, 1913.
29. F. P. 425545, 1911. D. R. P. Anm. G-31305.

C. Jeantaud,¹ I. Kitsee,² W. Leonard,³ C. Lopez,⁴ P. Marino,⁵ L. Merriam,⁶ A. Meygret,⁷ F. Moore,⁸ A. Oblasser and C. Theryc,⁹ M. Orban,¹⁰ Pontite, Ltd., and S. de Pont,¹¹ K. Smith,¹² D. Spill,¹³ W. Thompson,¹⁴ E. Weston,¹⁵ and F. Wynne and L. Powell.¹⁶

Celluloid labels, on account of their insolubility in water and permanency in other directions, have a wide field of usefulness, and are produced according to the directions of R. Lansing,¹⁷ D. Allport,¹⁸ G. Brandt,¹⁹ E. Brown,²⁰ B. Cohn,²¹ W. Herren,²² J. Harcombe,²³ J. Hyatt,²⁴ F. Koskul,²⁵ M. Lefferts,²⁶ S. Pierce,²⁷ V. Roybier,²⁸ A. and J. Todd.²⁹

Signs, cards and other display advertising may be protected from the elements by means of a coating of cellulose ester.

In the formation of articles of adornment and ornament, celluloid plays a most important part, various articles of head

30. E. P. 1228, 1896
31. E. P. 4678, 1898
32. E. P. 2649, 1870
1. F. P. 305088, 1903
2. U. S. P. 900744, 1908
3. U. S. P. 184043, 1876, abst. Chem. Tech. Mitth. 1878-1879, **22**, 295; Chem. Ind. 1878, **1**, 93
4. E. P. 13415, 1900, abst. Kunst. 1913, **3**, 410
5. E. P. 18590, 30602, 1909, abst. J. S. C. I. 1910, **29**, 1117
6. E. P. 3888, 1885
7. U. S. P. 698039, 1902, abst. J. S. C. I. 1902, **21**, 710, E. P. 22019, 1900; D. R. P. 152630.
8. U. S. P. 284970, abst. Kunst. 1913, **3**, 389
9. E. P. 19242, 1892
10. F. P. 372211, 1906
11. E. P. 3826, 1904
12. U. S. P. 1006697, abst. C. A. 1914, **4**, 36
13. U. S. P. 91378. See also M. Sweet, U. S. P. 1330835, 1920
14. E. P. 5061, 1898
15. E. P. 4458, 1882
16. E. P. 16805, 1885, **72**, 1886. See also Elektro-Material Ges. F. P. 143280, 1918; abst. J. S. C. I. 1920, **39**, 494-A
17. U. S. P. 513791, 1894. Can. P. 48294, 1895
18. E. P. 21361, 1897
19. E. P. 2895, 1905
20. Can. P. 66548, 1900
21. U. S. P. 627392, 1899
22. U. S. P. 657217, 1900
23. E. P. 6210, 1913 (transparent label on mattresses).
24. U. S. P. 218122, 1879
25. U. S. P. 289917, 1883
26. U. S. P. 238928, 1881
27. U. S. P. 617119, 1899. See also A. Becher, U. S. P. 788129, 1905
28. F. P. 440485, 1912
29. U. S. P. 93924, 1869.

dressing as toupees,¹ wigs, scalpettes,² and especially in the water proofing of sweat bands for hats. The processes of H. Wagenet,³ P. Lenhart,⁴ O. Drexler,⁵ A. Campbell,⁶ C. Kanouse,⁷ N. Marshman,⁸ J. Townsend,⁹ J. Beenken,¹⁰ F. O'Hanlon,¹¹ E. Diesser¹² and H. Keller¹³ belong to this category. In the general stiffening of hats by celluloid re-inforcement, the methods of R. Trested,¹⁴ H. Pearson,¹⁵ J. Kelsey,¹⁶ G. Roger,¹⁷ F. Royle,¹⁸ E. Hale,¹⁹ H. Koller,²⁰ J. Cleary,²¹ W. Williamson,²² and Bramco, Ltd.,²³ are illustrative.²⁴ The celluloid aviator helmet of J. Sloan,²⁵ the plastic ear protectors of A. Mallock²⁶ and J. Elliot,²⁷ the celluloid eardrum of E. Brown,²⁸ and the appliance for prevention of double

1. R. Buisson, F. P. 445860, 1911.
2. W. Schubbert, F. P. 1842, 1903.
3. U. S. P. 900330, 1908.
4. U. S. P. 104861, 1870.
5. E. P. 12098, 1908.
6. U. S. P. 365578, 1887.
7. U. S. P. 212948, 1879.
8. U. S. P. 938008, 1909.
9. U. S. P. 954708, 1910.
10. U. S. P. 960251, 1910.
11. E. P. 22747, 1911.
12. E. P. 9184, 1914.
13. E. P. 26072, 1904.
14. U. S. P. 224745, 1880.
15. E. P. 5072, 1906.
16. E. P. 13429, 1888.
17. E. P. 2775, 1860.
18. E. P. 22311, 1910.
19. E. P. 27732, 1911.
20. E. P. 26072, 1904.
21. E. P. 19565, 1911.
22. E. P. 23173, 1911.
23. E. P. 11928, 1913.
24. For general methods of hat sweats manufacture, see U. S. P. 209865, 254169, 932304, 185716, 198338, 198868, 199285, 201575, 204282, 206296, 209872, 210489, 211282, 211574, 212984, 215038, 233692, 217683, 218220, 218480, 220774, 246588, 222233, 229049, 189267, 246589, 248396, 255993, 282442, 347466, 919835, 917873, 986507, 877885, 890696, 900330, 941717, 908111, 938008, 949204, 954708, 960251, 966770, 1000439, 365474, 381208, 351402, 206918, 296919, 291157, 326081, 311751, 405417, 427995, 341616, 343717, 478291, 58622, 146692, 773349, 433985, 708872, 104861, 177452, 178689, 399729, 400417, 411155, 412201, 424336, 429341, 474540, 477751, 496929, 506839, 508316, 528777, 578394, 591289, 591311, 608724, 662645, 623148, 758800, 807570, 792533, 816391, 823314, 831444, 833587, 8902, 36344, 54986, 64417, 76685, 75685, 36557, 82364, 389962, 386634, 385092, 380175, 374654, 367266, 359772, 358859, 356614, 354924, 347891, 324082, Re. 9442, 9331, 9322, 8880, 7771.
25. E. P. 517, 1912.
26. E. P. 4821, 1914.
27. E. P. 19039, 1911.
28. E. P. 1437, 1905.

chin of M. Pollock¹ would naturally fall under this classification.

Transparent face protectors have found considerable use, as prepared in conformity with the ideas of A. Turner,² M. Galley,³ R. Smith,⁴ C. Weichert,⁵ H. Iscovesco,⁶ and A. Hendricks and G. Martin.⁷ Ear trumpets,⁸ ear screens,⁹ and ear expanders,¹⁰ all of celluloid, have been described. Transparent celluloid screens in connection with headwear to prevent glare from motor-car head lights¹¹ have found wide favor. The eye-shade devices of C. Mosher,¹² K. McGuanne,¹³ C. Sheldon,¹⁴ F. Bennett,¹⁵ R. Eggert¹⁶ and W. Belt and E. Bruckner¹⁷ have alleged inherent merit. The celluloid cheek plumper of O. Mayes,¹⁸ ladies collar supports,¹⁹ hat stiffeners,²⁰ and hearing appliances²¹ are indications of the diversified uses to which these plastics have been put. Spectacle frames,²² and glasses to protect the eye from injurious radiations,²³ have recently been used to a considerable extent.^{24,25}

Celluloid studs have for many years been widely used, their manufacture being based on the processes of J. Püschner,²⁶ A. Richter,²⁷ C. Pfennig,²⁸ E. Kempshall,²⁹ H. Milligan,³⁰ J. Lizotte,³¹

1. E. P. 10654, 1905.
2. E. P. 21347, 1899.
3. E. P. 18831, 1900.
4. E. P. 7442, 15849, 1907.
5. E. P. 13516, 1907.
6. E. P. 17233, 1890.
7. U. S. P. 797002, 1905.
8. E. Little, E. P. 19494, 1891.
9. E. Samson, E. P. 632, 1900.
10. J. Williams, E. P. 10288, 1907.
11. Bramco, Ltd., and Sturmey, E. P. 11928, 1913.
12. U. S. P. 569117, 1896.
13. Australian P. 17262.
14. U. S. P. 611396, 1898.
15. U. S. P. 583590, 1899.
16. U. S. P. 617676, 1899.
17. U. S. P. 613186, 1898.
18. U. S. P. 766367, 1904. I laughed myself when I read it.
19. Voeccklinghaus & Kerkenbusch, E. P. 21825, 1908. H. Hunt, E. P. 14482, 1906.
20. British Xylonite Co., and L. Merriam, E. P. 7738, 1887.
21. W. Haslam, E. P. 16176, 1913.
22. W. Eccleston, U. S. P. 792763, 1905.
23. W. Coblenz, J. Frank. Inst. 1919, **123**, 255; abst. C. A. 1919, **13**, 2579. See also C. A. 1919, **13**, 1136.
24. Am. Mail, **4**, 201.
25. J. Byron, E. P. 21318, 1907.
26. E. P. 2849, 1902.
27. E. P. 4729, 1908. See also E. P. 9008, 1901, 1348, 1903.

A. Mathison,¹ S. Gray,² J. Thierry,³ P. Kehr,⁴ J. Smith,⁵ E. Sibbald,⁶ W. Green,⁷ F. Egge,⁸ C. van Norman,⁹ P. Rowe,¹⁰ J. Hyer,¹¹ C. Gidley,¹² R. Halliwell,¹³ and E. Haynes.¹⁴

Celluloid eyelets, especially for shoes and gloves, may be made by taking a tube of plastic having one end flanged, one end being placed in a suitable former, where it is softened, the end being then turned over, thus forming the flange. This industry is primarily founded on the patents of E. Kempshall,¹⁵ F. Koch,¹⁶ O. Butin,¹⁷ J. Force,¹⁸ Florence Manufacturing Co.,¹⁹ P. Glass,²⁰ F. Hawkins,²¹ A. Latham,²² F. Richards,²³ and United Fast Color Eyelet Co.²⁴ In general, minor improvements are disclosed in the patented processes of B. d'Aubigne and E. Linch,²⁵ G. Braubrook,²⁶ M. Berger,²⁷ K. Büchler,²⁸ Boston Fast Color Eyelet Co.,²⁹

28. E. P. 6817, 1897.
29. U. S. P. 552841, 1896.
30. E. P. 2230, 1890.
31. U. S. P. 860814, 1907.
1. U. S. P. 525152, 1894.
2. E. P. 16999, 1906.
3. E. P. 8247, 1899.
4. E. P. 14343, 1896.
5. E. P. 2215, 1903.
6. E. P. 22675, 1904.
7. E. P. 9879, 1899.
8. U. S. P. 557526, 1896.
9. E. P. 6097, 1895.
10. E. P. 19644, 1905.
11. U. S. P. 548919, 1895.
12. E. P. 12717, 1898.
13. E. P. 15804, 1885.
14. E. P. 25646, 1905.
15. U. S. P. 545800, 551970, 1895; 553164, 1896; 599906, 600126, 606061, 612848, 1898; 639997, 1899; 700121, 1902; 789694, 789695, 1905. E. P. 23688, 1895; 5924, 5926, 7562, 1896; 29729, 1897; 5277, 1905; Can. P. 74803, 74804, 1902.
16. E. P. 25675, 1899. D. R. P. 138906, 138572; abst. Wag. Jahr. 1903, **49**, II, 570.
17. E. P. 27001, 1898.
18. U. S. P. 701476, 1902. W. Force, M. Parenteau and A. Cutler, E. P. 23680, 1895; U. S. P. 551079, 1895; 596264, 1897.
19. E. P. 22125, 22126, 27296, 1896.
20. U. S. P. 795033, 799042, 1905; 849605, 1907; 889455, 1908.
21. U. S. P. 483784, 1892; 584353, 1897. E. P. 14514, 1897.
22. U. S. P. 568360, 571837, 1896; 579275, 1897; E. P. 15249, 1895.
23. U. S. P. 903778, 1908; 910861, 1909.
24. E. P. 2036, 2037, 2038, 1902.
25. E. P. 701, 1901.
26. U. S. P. 759804, 777937, 1904.
27. E. P. 16730, 1913.
28. E. P. 26610, 1908.
29. E. P. 15204, 1908.

W. Carpenter,¹ A. Estabrook,² J. Engels,³ F. Egge and N. Miles,⁴ H. Fishel,⁵ J. Hurst and H. Dowler,⁶ Hubert & Co. and J. Thierry,⁷ T. King,⁸ A. Mathison,⁹ J. Morrison, D. Gibb and W. Gibb,¹⁰ F. Neuberth,¹¹ C. van Norman,¹² A. Prym,¹³ E. Pupke,¹⁴ W. Smidt,¹⁵ J. Schloss,¹⁶ J. and A. Thierry,¹⁷ H. Vogel,¹⁸ T. Hilditch,¹⁹ and H. Walden.²⁰ Agatine and Rodite are trade names for celluloid shoe eyelets. The manufacture of celluloid buttons and button-holes is no less important an industry than that of eyelet fabrication. Full details are disclosed in the processes of W. Delf,²¹ A. Denk,²² W. Edkins,²³ J. France,²⁴ G. and A. Grove,²⁵ W. Hornich,²⁶ Hammer & Vorsak,²⁷ J. Jacobson,²⁸ P. Kehr,²⁹ R. Lokesch,³⁰ J. Naylor,³¹ P. Quijano,³² Rutgerswerke Akt. Ges.,³³ F. Reddaway and M. Dessau,³⁴ F. Richter,³⁵ O. Schwarze,³⁶ Soc. Meunier et Fumet,³⁷

1. U. S. P. 271035, 1883
2. U. S. P. 568010, 1896
3. E. P. 12107, 1900, 22148, 1901
4. E. P. 7001, 1896
5. E. P. 9206, 1893
6. E. P. 13001, 1905
7. E. P. 20303, 1904
8. E. P. 16495, 1895
9. E. P. 13484, 1893
10. E. P. 10787, 1905
11. E. P. 8896, 1905
12. E. P. 10420, 1898
13. E. P. 15870, 1896
14. U. S. P. 520598, 1894
15. E. P. 16238, 1889, 14180, 1890
16. U. S. P. 624404, 1899 E. P. 22659, 1906
17. E. P. 2134, 1885, 18331, 1891
18. D. R. P. 205034
19. E. P. 138220, 1919
20. U. S. P. 785281, 1905 See also E. Stoefler, U. S. P. 675451, 1901.
21. E. P. 11888, 1903
22. E. P. 10639, 1893
23. E. P. 22397, 1906
24. U. S. P. 421860, 1900
25. E. P. 13046, 1904
26. U. S. P. 249048, 1881
27. Aust. P. 24666, 1906. See also Bensinger & Co., D. R. P. 154992, 1904.
28. U. S. P. 467661, 1892. E. P. 1596, 1892.
29. E. P. 14343, 1896.
30. E. P. 20037, 1898.
31. U. S. P. 235799, 1890.
32. E. P. 564, 1904.
33. E. P. 27764, 1910.
34. E. P. 9679, 1901.
35. E. P. 4729, 1908.
36. E. P. 28471, 28472, 1911.
37. E. P. 17127, 1911.

J. Schowanek,¹ M. Shipman,² J. Schmahl,³ A. Townsend,⁴ H. Tindall,⁵ H. Thier,⁶ and the United Fast Color Eyelet Co.⁷

Manufacture of collars, cuffs and shirt bosom fronts. This is one of the principal activities in the pyroxylin plastic industry which, as the culmination of years of careful experimentation, has reached a high degree of perfection, both from an artistic and utilitarian point of view. The earlier endeavors of W. Hunt,⁸ W. Lockwood⁹ and J. Barton¹⁰ contained no cellulose nitrate. In 1865 a distinct advance was made by G. Ray,¹¹ who coated paper with pyroxylin and fashioned collars and cuffs therefrom. A. Rollason, in 1858,¹² and Barnwell and Rollason the succeeding year,¹³ suggested that pyroxylin might be used for this purpose, but did not put the suggestion into successful operation.

It remained for A. and R. Sanborn and A. Kanouse¹⁴ to crystallize the efforts of their predecessors into a tangible, practical process, their patent being granted in 1878. J. and I. Hyatt,¹⁵ E. Kipper¹⁶ and J. France¹⁷ also made substantial advances.¹⁸

1. F. P. 469148, 1914.
2. U. S. P. 707456, 1902.
3. U. S. P. 379289, 1888.
4. E. P. 13325, 1911.
5. E. P. 23360, 1903.
6. E. P. 22577, 1892.
7. E. P. 2036, 1902.
8. U. S. P. 11376, 1854, Re. 1828, 1865; 1867, 1865, 1927, 1865, 2306, 2307, 1866; 5109, 1872.
9. U. S. P. 23771, 1859. See also A. Granger, E. P. 2140, 1861.
10. U. S. P. 52659, 1866.
11. U. S. P. 48239, 1865.
12. E. P. 2349, 2849, 1858.
13. E. P. 945, 1850; 2249, 1860.
14. U. S. P. 200939, 1878. See also A. Sanborn, U. S. P. 221977, 233878, 258480, 288055. C. Kanouse, U. S. P. 254875, 1882.
15. U. S. P. 276248, 1883; 419257, 419258, 419259, 419260, 419261, 419262, 419263, 422303, 436787, 455333. See also P. Aub, U. S. P. 147588, 1874.
16. U. S. P. 322729, 1885; 330838, 388287, 425679, 1890. See also E. Kipper and J. Jarvis, U. S. P. 425679, 1890.
17. U. S. P. 392794, 1888; 393750, 393751, 393752, 393753, 418787, 421860, 425129. E. P. 16465, 1888.
18. D. Smith, U. S. P. 150722, 1874. In this connection see J. Brockway, U. S. P. 113735, 113736, 1871. L. Bunn, E. P. 13713, 1851. L. Cornides, E. P. 745, 1855. L. Crane, U. S. P. 58223, 1866. J. Cutting, E. P. 1638, 1854. L. Deitz, U. S. P. 113272, 1871; 133969, 1872. C. Ensign, U. S. P. 106725, 1870. A. Granger, E. P. 2140, 1861. F. Greening, U. S. P. 172995, 1876; F. P. 110571, 1875. T. Henley and D. Spill, E. P. 2649, 1870. A. Job and E. Tomlinson, E. P. 1974, 1855. N. Jones, U. S. P. 136735, 1873. A. Newton, E. P. 13542, 1861. A. Pitman, U. S. P. 172486, 173999.

The various refinements which have been introduced in developing this art to its present state of perfection are recorded in the improvements embodied in the processes of A. Aub,¹ British Xylonite Co. and L. Merriam,² H. Brown,³ W. Chisholm,⁴ E. Closmann,⁵ Celluloid Mfg. Co.,⁶ E. Cary,⁷ W. Donald and J. Mitchell,⁸ R. Dittmer,⁹ J. Edson,¹⁰ M. Friedly,¹¹ H. Fox,¹² W. Groom,¹³ C. Gidley,¹⁴ A. Granger,¹⁵ J. Gill,¹⁶ W. McGlashan,¹⁷ G. Goldsmith and A. Merrill,¹⁸ H. Hunt,¹⁹ R. Hunter,²⁰ J. Hampson,²¹ T. Hardcastle,²² J. Hancock,²³ J. Jarvis,²⁴ J. Jeffs,²⁵ W. Lockwood,²⁶ A. Marble,²⁷ J. France,²⁸ G. Moysan,²⁹ W. McGlashan,³⁰ H. Mann,³¹ H. Milligan,³² J. Osborne,³³ W. Parsons, F. Wright and W. Callaghan,³⁴ W. Power,³⁵ J. Parsons,³⁶ H. Peters,³⁷ G. Klaar,³⁸ M. True-

174000, 174001, 174002, 190363, 1877 I. Post, U. S. P. 126760, 1873 W. Smith, U. S. P. Re 2656, 3014, 1868. P. Leziard, E. P. 136778, 1919.

- 1 E. P. 3832, 1874
- 2 E. P. 7738, 1887, abst J. S. C. I. 1887, **6**, 559
- 3 Can. P. 46786, 1896.
- 4 E. P. 3384, 1911; abst C. A. 1912, **6**, 2172
- 5 U. S. P. 861435, 1907, abst J. S. C. I. 1907, **26**, 1007 E. P. 8618, 1907. D. R. P. 190671, abst. Wag. Jahr. 1907, **53**, II, 430, Chem. Tech. Rep. 108, **32**, 11
- 6 E. P. 682, 683, 1890
- 7 U. S. P. 253001, 1882.
- 8 Can. P. 46691, 1895.
- 9 E. P. 4877, 1911.
- 10 U. S. P. 289240, 289242, 1883
- 11 E. P. 11597, 1892.
- 12 U. S. P. 234665, 1880
- 13 U. S. P. 339006, 1896.
- 14 E. P. 12717, 1898
- 15 E. P. 2140, 1861
- 16 E. P. 25950, 1902
- 17 E. P. 6334, 1905.
- 18 U. S. P. 505399, 1893.
- 19 E. P. 14482, 1906
- 20 U. S. P. 520825, 1894.
- 21 E. P. 16274, 1911
- 22 E. P. 7943, 1896.
- 23 E. P. 3776, 1906.
- 24 U. S. P. 343903, 1896
- 25 E. P. 2923, 1861.
- 26 U. S. P. 23771, 1859; Re 5259, 1873
- 27 U. S. P. 493830, 1893
- 28 E. P. 17691, 1888
- 29 E. P. 16747, 1892.
- 30 E. P. 6334, 1905.
- 31 U. S. P. 700793, 1902.
- 32 U. S. P. 421137, 1890. E. P. 2239, 1890.
- 33 U. S. P. 808472, 808473, 1905.
- 34 E. P. 13611, 1909.
- 35 E. P. 27751, 1907.

blood,¹ Tondlo & Co.,² Vöcklinghaus and Kerkenbusch,³ F. Upton,⁴ and J. Woodbury.⁵

A. Zimmer waterproofs collars and cuffs either with nitrocellulose,⁶ or with cellulose acetate.⁷

Celluloid necktie retainers or adjusters are used extensively in some sections of the country, more especially in the rural districts. The details of their construction and application are to be found in the description of the processes for manufacture of F. Bessette,⁸ F. Gould,⁹ J. Gill,¹⁰ H. Humphrey and W. Brown,¹¹ R. Halliwell,¹² E. Lüdke,¹³ P. McGinn,¹⁴ A. Monnington,¹⁵ W. Power,¹⁶ J. Mackay,¹⁷ A. Swanson,¹⁸ H. Schmidt,¹⁹ and A. Weibel.²⁰ In shoe manufacture, celluloid has been put to a number of important uses, and we find lacing fastenings, as devised by E. Kempshall,²¹ J. Engels,²² F. Egge,²³ T. Benwell,²⁴ A. v. Gillern,²⁵ E.

36. U. S. P. 353642, 1886.
37. E. P. 870, 1910.
38. E. P. 3917, 1906.
1. Can. P. 111544.
2. E. P. 15782, 1913; abst. C. A. 1915, **9**, 156 E. P. 13895, 1913.
3. E. P. 21825, 1908.
4. E. P. 1358, 1898.
5. E. P. 1537, 1865.
6. U. S. P. 1025731, 1912, abst. C. A. 1912, **6**, 1994.
7. E. P. 2406, 1910; abst. J. S. C. I. 1911, **30**, 206; D. R. P. 242786, 1910; abst. C. A. 1912, **6**, 2182, Wag. Jahr. 1912, **58**, II, 509. For data on shirt bosom compositions see U. S. P. 5019, 30842, 40426, 44781, 45566, 46172, 46567, 49039, 49703, 49747, 52784, 52812, 52907, 53455, 55451, 58131, 58561, 58673, 62550, 101794, 127974, 136247, 143205, 144267, 157890, 161403, 166297, 166411, 170244, 171919, 188105, 208191, 212265, 215743, 264506, 280836, 285699, 290053, 310691, 338563, 343006, 371668, 442986, 487000, 555974, 559425, 589912, 604970, 646356, 652164, 693226, 743455, 760142, 789354, 861427, 901457, 928655, 966867.
8. Can. P. 47413, 1894.
9. E. P. 14691, 1908.
10. E. P. 25950, 1902.
11. E. P. 8944, 1901.
12. E. P. 15304, 1885.
13. E. P. 21209, 1897.
14. E. P. 11169, 1906.
15. E. P. 13597, 1911.
16. E. P. 27751, 1907.
17. New Zealand P. 32619, 1913.
18. E. P. 7587, 1908.
19. E. P. 18157, 1911. See also E. P. 1851, 1907; 10270, 1910. See also W. Hearsey, E. P. 143151, 1919.
20. E. P. 3710, 1907.
21. U. S. P. 532204, 1895; 569909, 569971, 1896; 579112, 586771, 586772, 1897; 599905, 1898; 700122, 1902. E. P. 5925, 1896; 10918, 15085, 1897.
22. E. P. 18732, 1900.
23. U. S. P. 456303, 1891. F. Egge and N. Beach, E. P. 7001, 1896.
24. U. S. P. 427958, 1890.
25. E. P. 7425, 1908.

Gallison,¹ M. Bray,² A. Estabrook,³ W. Smidt,⁴ United Fast Color Eyelet Co.,⁵ and C. Van Norman.⁶ Methods for the manufacture and use of celluloid shoe tips,⁷ insoles,⁸ footarch supports,⁹ heels,¹⁰ shoe lasts,¹¹ shoe tips,¹² boot uppers,¹³ lacing tips¹⁴ and strips,¹⁵ shoe enamels,¹⁶ shoe patches,¹⁷ shoe hook caps,¹⁸ shoe stiffeners,¹⁹ and shoe bottom fillers²⁰ are to be found in the literature, and are indicative of the diversified uses to which this plastic has been put in this connection. The processes of W. Carpenter,²¹ D. Heinsohn,²² L. Levy,²³ T. Clarke,²⁴ F. Oliver,²⁵ and P. Vorsteler²⁶ are for processes similar to the above. R. Crompton has patented a celluloid horse shoe.²⁷

As far back as 1879, H. Schultz was given protection for a celluloid stay²⁸ having no metal tips to rust, or whalebone to lose its resiliency after a while, and due to subsequent refinements in manufacture as devised by C. MacKay,²⁹ H. Guenther,³⁰ J.

1. U. S. P. 1040662, 1912
2. U. S. P. 477242, 1892; 548512, 1895
3. U. S. P. 576045, 1897.
4. U. S. P. 568498, 1896; E. P. 16238, 1899.
5. E. P. 2038, 1902.
6. U. S. P. 565099, 1896
7. J. Hyatt, U. S. P. 203834, 1878.
8. C. Kanouse, U. S. P. 219484, 1879 G. Prohle, U. S. P. 1018132, 1912.
9. S. Korn, E. P. 10988, 1912.
10. E. Stoeffler, U. S. P. 675451, 1901
11. A. Lorant, E. P. 25939, 1902
12. K. Schilling, D. R. P. 178438, 1905
13. J. and A. Thierry, E. P. 2134, 1885 J. Thierry, E. P. 8247, 1899
14. M. Bortree, U. S. P. 575387, 1897.
15. D. Berry, E. P. 1377, 1902.
16. C. Orcutt, U. S. P. 114470, 1871.
17. Deutsche Gummiwaren-Industrie Schlappig & Co., and O. Schlap pig, E. P. 25541, 1911.
18. F. Mostert, D. R. P. 228381, 1909, abst. Kunst. 1911, 4, 17.
19. K. Lengfellner, E. P. 25726, 26033, 1908 Swiss P. 43470, 1908
20. D. R. P. 206223 F. P. 396814, 1908.
21. Livingston & Doughty, Ltd., E. P. 4402, 1910 See also Thomas, E. P. 17667, 1906.
22. U. S. P. 256198, 1882.
23. E. P. 12016, 1906.
24. E. P. 16632, 1904.
25. E. P. 24800, 1908.
26. E. P. 10104, 1896.
27. E. P. 13225, 1912.
28. E. P. 15052, 1888. Perhaps good luck to the inventor. See also Marschaik, Kunst. 1914, 4, 385. Chem. Eng. 19, 199; abst. C. A. 1914, 8, 2637; F. Rampichini, E. P. 7086, 1913. Addn. to E. P. 5350, 1912. E. P. 14586, 1910; 5350, 1912; 7086, 1913.
29. E. P. 3170, 1879.
30. U. S. P. 473161, 1892. Can. P. 31778, 1889.
31. Swiss P. 55412.

Schloss,¹ E. Haworth,² A. Fletcher,³ E. Warren and J. Holden,⁴ G. Klaar,⁵ E. Cohn,⁶ M. Lefferts,⁷ N. Hunt,⁸ C. Hagen,⁹ and H. Chapman,¹⁰ the use of celluloid stays and dress stiffeners, has almost superseded all other materials for the purpose of inducing rigidity at fixed points in ladies wearing apparel. Fulfilling similar functions are the celluloid artificial whalebone compositions, of G. Phelps,¹¹ T. Haslam,¹² A. Gavard and J. Thompson,¹³ L. Munk,¹⁴ J. Wahlen,¹⁵ K. Hartmann,¹⁶ H. Knight,¹⁷ and E. Lilliendahl.¹⁸

Wearing apparel may be reinforced by the use of celluloid coated thread, "Le Celluloid arme", of J. de Chazelles,¹⁹ being an example of small wire or thread covered with a thin coating of pyroxylin plastic. The processes of E. Delagrangé,²⁰ V. Montain,²¹ Keilmann Bro.,²² E. Breuer,²³ and E. Dubot²⁴ are analogous.

E. Leak and T. Wilson employ celluloid travelers for the ring spinning of thread.²⁵ In the manufacture of celluloid fabrics, both plain and inlaid, details are to be found in the descriptions of D. Cohen,²⁶ J. McClelland,²⁷ British Xylonite Co. and L. Merriam,²⁸ and T. Schmidt & Co.²⁹ H. Schultz fashions busks and

1. E. P. 22659, 1906.
2. E. P. 22651, 1910.
3. E. P. 6995, 1911.
4. U. S. P. 559827, 1896.
5. E. P. 3917, 1906. Can. P. 112788.
6. E. P. 27047, 1905.
7. U. S. P. 238927, 1881.
8. U. S. P. 556928, 1896.
9. U. S. P. 905420, 1908. Can. P. 115068.
10. U. S. P. 813618, 1906.
11. U. S. P. 251731, 1881; abst. J. S. C. I. 1882, **1**, 113.
12. E. P. 21587, 1891; abst. J. S. C. I. 1893, **12**, 37.
13. E. P. 1488, 1892.
14. E. P. 11521, 1892.
15. E. P. 24634, 1893.
16. E. P. 10810, 1911.
17. E. P. 1765, 1890.
18. E. P. 18606, 1912.
19. Belg. P. 171765, 1903.
20. E. P. 16332, 1900.
21. E. P. 433071; abst. Kunst. 1911, **1**, 214.
22. E. P. 10966, 1911.
23. D. R. P. 55293; abst. Chem. Tech. Rep. 1891, **30**, I, 122.
24. E. P. 126263, 1919, abst. J. S. C. I. 1919, **38**, 409A.
25. E. P. 1110, 1888.
26. E. P. 25149, 1910.
27. U. S. P. 271493, 1883. Cf. F. Brockhaus, D. R. P. 148101, 1902.
28. E. P. 7738, 1887; abst. J. S. C. I. 1887, **6**, 559. Celluloid-backed typewriter ribbons are described by P. Ramus, Can. P. 169578.
29. Swiss P. 69514; abst. Kunst. 1915, **5**, 238.

fasteners for stays out of xylonite¹ according to a patent process.

In dress shields, celluloid makes an admirable material, and methods of its utilization for this purpose have been described by J. Braunstein,² M. Pitsch,³ N. Nevin,⁴ D. Basch,⁵ C. de Guerin,⁶ M. McMann,⁷ and S. Greene.⁸ Celluloid buckles have been also used quite extensively, being produced by the processes of A. Burke,⁹ P. Martin,¹⁰ and E. Steele.¹¹ B. and J. Hayes have patented a celluloid belt.¹² Other application of the pyroxylin plastics in connection with wearing apparel and as intimating the various uses may be tabulated beads,¹³ pocket-mouth reinforcements,¹⁴ lace stiffeners,¹⁵ coated metal hooks,¹⁶ skirt,¹⁷ belt¹⁸ and bodice fastenings,¹⁹ feathers²⁰ and plumes,²¹ glove,²² shoe,²³ waist²⁴ and corset²⁵ fasteners, flexible needles,²⁶ collar tabs,²⁷ beads,²⁸ faced metal articles,²⁹ and mirror backs,³⁰ must almost exhaust the category. Even handkerchiefs of celluloid have been described,³¹ and one wag has gone so far as to advocate the employment

1. E. P. 3170, 1879.
2. E. P. 806, 1912.
3. E. P. 2431, 1895.
4. U. S. P. 946766, 1910. E. P. 23829, 1912, Can. P. 131990, 1911.
5. U. S. P. 887454, 1908.
6. E. P. 1054, 1915.
7. U. S. P. 867830, 1907.
8. E. P. 13932, 1899.
9. U. S. P. 979744, 1910.
10. E. P. 548, 1901.
11. E. P. 9934, 1901.
12. U. S. P. 233414, 1880.
13. H. Fishel, E. P. 9206, 1893.
14. H. Tindall, E. P. 23360, 1903.
15. J. Duquette, E. P. 28196, 1911.
16. D. Heinsohn, E. P. 12016, 1906.
17. G. Adams, E. P. 14674, 1897.
18. E. Cohn, E. P. 27047, 1905.
19. G. Printer, E. P. 14674, 1897.
20. W. Read and Wardle & Davenport, E. P. 10187, 1912.
21. L. Loeser, Chem. Tech. Rep. 1886, **25**, I, 119.
22. W. Carpenter, U. S. P. 256198, 1882.
23. J. Richardson and A. Marr, E. P. 2611, 1905.
24. E. and R. Donagan, E. P. 8411, 1913.
25. C. Bergner, E. P. 13614, 1913.
26. P. Durando, E. P. 463804, abst. Kunst. 1914, **4**, 294.
27. J. Kaufman, E. P. 10421, 1913.
28. E. Heusch, E. P. 9266, 1900.
29. United Fast Color Eyelet Co., E. P. 2036, 1902.
30. E. Reinhardt, U. S. P. 578362, 1897.
31. P. Petrie, E. P. 11644, 1913. See also Halbach & Boeckmann, D. R. P. 250280, 1911; abst. Kunst. 1912, **2**, 319, 336. See also Bull. Soc. Franc. Phot. 1883, **29**, 320. Pap. Ztg. 1887, **4**, 748. Huttm. Ztg. 1880, 14. Zts. Dreschler, **15**, 190.

of celluloid razor blades, which probably at least are "safety."

Long since have the sticks and tips of umbrellas, parasols, sunshades and canes been prepared of celluloid, as exemplified in the ingenuity of S. Learoyd,¹ Schreiner and Sievers,² J. Furman,³ J. and H. Gembicki,⁴ J. France,⁵ W. Burnett,⁶ and H. Guenther.⁷ In the manufacture and assembling of the cheaper and imitation jewelry, celluloid for a long time has played a leading part. Bangles,⁸ spangles,⁹ jewelry,¹⁰ rings,¹¹ and ring protectors, finger protectors,¹² pocket clips for fountain pens,¹³ jewel slides,¹⁴ wristlets¹⁵ and wrist watch protectors,¹⁶ thimbles¹⁷ and thimble blanks,¹⁸ necklaces,¹⁹ and necklace fastenings,²⁰ bracelets,²¹ and fasteners therefore,²² jewelry clasps²³ and gem inlaying,²⁴ clock cases,²⁵ initials,²⁶ intaglio design,²⁷ and butterflies²⁸ and artificial flowers²⁹ must almost complete the list.

Beautiful fans³⁰ and lorgnette holders are made of celluloid.

1. E. P. 11706, 1895.
2. D. R. P. 62674; abst. Wag. Jahr. 1892, **38**, 1066; Ber. 1892, **25**, 609; Chem. Tech. Rep. 1892, **31**, II, 87; Ind. Bl. 1892, 286.
3. U. S. P. 408965, 1889.
4. D. R. P. 173259, 115.
5. U. S. P. 430520, 1890.
6. E. P. 6770, 1913. See also E. P. 12092, 1884; 14931, 1886; 15389, 1907.
7. Aust. P. 54416, 1911. See also N. Erfind. Erfahr. 1895, **22**, 301.
8. F. P. 464997; abst. Kunst. 1914, **4**, 295. C. Bose, India P. Appl. 238, 560, 1906.
9. E. Dobler, D. R. P. 245994.
10. C. Fechter, D. R. P. 225465, 1910.
11. W. Carroll and J. Seary, E. P. 20155, 1895.
12. E. Brown, E. P. 5525, 1906.
13. N. Gargano, E. P. 26035, 1903.
14. P. Martin, E. P. 548, 1901.
15. G. Baldeck, E. P. 4363, 1900.
16. J. Beebe, E. P. 1760, 1901. Watch crystals of celluloid, L. Wachter, E. P. 137006, 1919. See B. Ames, U. S. P. 1133780, and Re. 14458 thereon.
17. C. Iles, E. P. 818, 1899.
18. W. Halsey, U. S. P. 224682, 1882.
19. M. Perier, E. P. 29990, 1912.
20. J. Maden, E. P. 9538, 1901.
21. F. Maske, F. P. 375393, 1907.
22. W. Jennens, E. P. 9897, 1912.
23. D. Perkins, U. S. P. 776256, 1904.
24. H. Aumont, E. P. 4203, 1894. See also Soc. anon. l'Oyonnithé, F. P. 458002.
25. R. Triplett, U. S. P. 255355, 1882.
26. A. Mason, E. P. 24180, 1899.
27. C. Smith, E. P. 1851, 1905.
28. E. Paltscho, E. P. 27898, 1902.
29. A. Richter, U. S. P. 644724. M. Souchet, U. S. P. 490170, 1893; F. P. 150203, 157811, 1883.
30. R. Smith, E. P. 15849, 1907.

A. Parkes, in 1866,¹ first described the application of pyrox-
ylin plastics as agglutinant in holding together the bristles of
brushes. The manufacture of tooth, nail, hair and other brushes,
with backs and handles of celluloid has developed into a large
industry. The first Hyatt patent for a plastic-backed brush
issued in 1874,² and was followed chronologically by those of I.
Hyatt,³ E. Kipper,⁴ W. Booth,⁵ H. Miller,⁶ E. Michaelis,⁷ A.
Sonn,⁸ C. Flemming,⁹ G. Wagner and S. Herne,¹⁰ H. Alexander¹¹
and A. Maschmeijer.¹² The Rubberset shaving brush—sold
throughout the world—is based on the patents of F. Graul,¹³ the
H. Belknap brush¹⁴ being similar. C. Goehring,¹⁵ and H. Baux
and L. Glaenger¹⁶ have also described processes for molding
celluloid brush backs.¹⁷

M. Schall has described,¹⁸ and C. Rohe patented¹⁹ processes
for the preparation of bristles of celluloid, and B. Borzykowski²⁰
of cellulose acetate. An important feature of celluloid industry in
this connection is the formation of plastic tooth brushes, processes
for so doing having been published by W. Wallach,²¹ J. Baker,²²
R. Günther,²³ C. Bamfield,²⁴ C. Heilrath,²⁵ E. Kuzzer,²⁶ Will &

1. E. P. 1592, 1866.
2. U. S. P. 156355, 1874; 195010, 1877.
3. E. P. 3715, 1877.
4. U. S. P. 333469, 1885.
5. U. S. P. 329128, 1885.
6. U. S. P. 345983, 1896; 605185, 1898.
7. E. P. 20220, 1899.
8. U. S. P. 789178, 1905.
9. U. S. P. 707574, 1902. E. P. 8689, 1896.
10. U. S. P. 850551, 1907.
11. U. S. P. 916383, 1909.
12. D. R. P. 291652, 1915; abst. C. A. 1917, **11**, 1274.
13. U. S. P. 800291, 1905; Rubber and Celluloid Harness Trimming
Co., Can. P. 121835, 1909.
14. U. S. P. 949642, 1910.
15. U. S. P. 639376, 1899.
16. E. P. 21443, 1894.
17. Koyl, Uhland's Wochen. für Ind. u. Technik, 1891, **6**, 50. Stuebeling,
Zts. Bürsten, 1898, **17**, 177; **26**, 557.
18. Kunst. 1914, **4**, 337; abst. C. A. 1915, **9**, 128.
19. D. R. P. 101040; abst. Wag. Jahr. 1899, **45**, 1156.
20. U. S. P. 1010222, 1911; abst. J. S. C. I. 1912, **31**, 24; F. P. 424428,
1910; abst. J. S. C. I. 1911, **30**, 740.
21. U. S. P. 623058, 1894.
22. E. P. 13994, 1913. See E. P. 4985, 1881; 13142, 1884; 6028, 1892;
19406, 1896; 9826, 1907.
23. E. P. 19504, 1911; F. P. 433860.
24. E. P. 9388, 1912.
25. U. S. P. 766247, 1904.
26. U. S. P. 890143, 1908.

Finck Co.,¹ and including the celluloid brush case of H. Bessen,² and the tooth brush of W. McMillan.³

In the formation of celluloid mirror backs,⁴ the industry was founded on the patents of C. Koyl,⁵ J. France,⁶ H. Miller,⁷ J. Hyatt,⁸ K. Zëun,⁹ and E. Kipper and E. Edson,¹⁰ being subsequently extended by the inventions of J. Wilcox,¹¹ A. Burke,¹² J. Komorous,¹³ and A. Perot.¹⁴

At the present time hair pins, barrettes, and similar ornaments for the coiffure are almost entirely constructed of celluloid. This branch of the plastic art has been developed from the inventions of W. Wise,¹⁵ A. Bates,¹⁶ C. Atkinson,¹⁷ A. Mason,¹⁸ W. Pfaff,¹⁹ S. Goldberg,²⁰ B. Lederer,²¹ A. Schärer,²² T. Roos,²³ D. Haywood,²⁴ G. Petticolin,²⁵ F. Geffers,²⁶ J. and A. Thierry,²⁷ W. Bechtold,²⁸ W. Hines,²⁹ R. Ostenhoudt,³⁰ W. Yeomans,³¹ W. Pop-

1. E. P. 13341, 1894.
2. U. S. P. 573852, 1896.
3. F. P. 454038, 1913.
4. M. Vohl, Amer. J. Pharm. 1850, **22**, 65. Anthony Photo Bull. 1890, **21**, 389. Cosmos, 1893, **25**, 514. Wilson's Photographic Mosaics, 1895, 101.
5. U. S. P. 418136, 1889. D. R. P. 58500; abst. Wag. Jahr. 1891, **37**, 1176; Umland's Woch. Ind. 1891, **6**, 50; Gewerbl. aus Württemberg, 1891, **43**, 390; N. Erfind. Erfahr. 1892, **19**, 132.
6. U. S. P. 478851, 1892.
7. U. S. P. 345082, 1886; 592877, 1897, 621360, 1899.
8. J. Hyatt and C. Lockwood, U. S. P. 286541, 1883.
9. U. S. P. 246270, 1881.
10. U. S. P. 299804, 1884.
11. U. S. P. 951497, 971712, 1910.
12. U. S. P. 1240175, 1917.
13. U. S. P. 858079, 1907.
14. Compt. rend. 1909, **149**, 725; abst. J. S. C. I. 1909, **28**, 1199.
15. E. P. 553, 1885.
16. U. S. P. 628596, 1899.
17. E. P. 7251, 1900.
18. E. P. 24180, 1899.
19. E. P. 2421, 1899.
20. E. P. 28479, 1903.
21. U. S. P. 662949, 1900.
22. U. S. P. 837735, 1906.
23. U. S. P. 781024, 787400, 1905.
24. U. S. P. 832127, 1906; 862475, 1907.
25. E. P. 19053, 1908. Aust. P. 40599, 1909.
26. D. R. P. 226159, 1909; abst. Wag. Jahr. 1910, **56**, II, 590; Kunst. 1911, **1**.
27. E. P. 19053, 1908; 359, 1899; 21834, 1901; 23852, 1907. F. P. 424997.
28. E. P. 409, 1898. See also Societe La Bellignite, F. P. 446108, 1911.
29. U. S. P. 665989, 1901; 709255, 1902.
30. U. S. P. 1020424, 1912.
31. U. S. P. 827386, 1906.
31. U. S. P. 926450, 1909.

pendieck,¹ V. Roybier,² A. Needs,³ B. Scott,⁴ P. Watson,⁵ I. Shearer,⁶ H. Traun,⁷ C. Bensinger⁸ and E. Schmidt.⁹

No less important than the above for ornamentation of the hair are celluloid and other nitrocellulose-containing plastics. Their manufacture on a satisfactory commercial basis may be said to have commenced in 1877, in which year protection was granted to J. Hyatt¹⁰ for the manufacture of celluloid combs in which nearly all the previous defects found in wood, horn and metal were satisfactorily overcome. From this initial process have sprung the subsequent refinements of Anglo-American Tooth Manufacturing Co.,¹¹ W. Bechtold,¹² C. Bensinger,¹³ W. Booth,¹⁴ L. Bondet,¹⁵ A. Burke,¹⁶ L. Brun,¹⁷ E. Brown,¹⁸ W. Beresford,¹⁹ W. Crabb,²⁰ E. Carrez,²¹ F. Cook and C. Stannard,²² D. Chandler,²³ G. Convert,²⁴ P. Durando,²⁵ H. Dawn,²⁶ L. Desvaux,²⁷ G. Delory,²⁸ W. Dun Lany,²⁹ A. Durgin,³⁰ Erste Prager Celluloid-Kammwarenfabrik Bruder Lux,³¹ I. Frechette,³² F. Germani,³³

1. U. S. P. 850780, 1907.
2. F. P. 424997, 1911; abst. Kunst 1911, **1**, 318.
3. U. S. P. 910715, 1909.
4. U. S. P. 938715, 1909.
5. U. S. P. 958339, 1910.
6. E. P. 3509, 1910.
7. E. P. 359, 1899.
8. E. P. 21834, 1901, 26838, 1902.
9. E. P. 23852, 1907.
10. U. S. P. 199009, 1878.
11. D. R. P. Ann. A-21224, 1911.
12. U. S. P. 859798, 1907; 897188, 1908, 922838, 1909.
13. U. S. P. 688222, 688223, 1901, Re 11976, 759413, 1904; 1124691, 1915.
14. E. P. 21834, 1901; 26838, 1902.
15. U. S. P. 223311, 1880, 884456, abst. Kunst 1913, **3**, 467.
16. D. R. P. 190903, 1906.
17. U. S. P. 937223, 1909.
18. F. P. 457066, 1913.
19. U. S. P. 232449, 1880.
20. E. P. 12118, 1904.
21. U. S. P. 294204, 1884; E. P. 3936, 1884; Can. P. 20464, 1884.
22. F. P. 444992; abst. Kunst. 1913, **3**, 57.
23. U. S. P. 1072915, abst. Kunst 1914, **4**, 195.
24. U. S. P. 998675, 1911.
25. F. P. 375030, 1907.
26. F. P. 462862, 463804, 1914; abst. Kunst. 1914, **4**, 294. Cf. U. S. P. 857387, 1907.
27. U. S. P. 235344, 1880.
28. E. P. 9313, 1908; abst. J. S. C. I. 1908, **27**, 956; F. P. 388097, 1908; abst. J. S. C. I. 1908, **27**, 873; U. S. P. 929060.
29. U. S. P. 804522, 1905.
30. U. S. P. 706036, 1902.
31. U. S. P. 660893, 1900; 707563, 707564, 761604, 1904.
32. D. R. P. 266359, 1911; abst. Kunst. 1914, **4**, 37; Aust. P. 52919,

J. Hyatt,¹ P. Hoffmann,² G. Huebener,³ W. Hope,⁴ S. Herrick and C. Lunger,⁵ W. Hines,⁶ O. Gallup,⁷ J. Gillum,⁸ J. Hackenberg,⁹ H. Jullian,¹⁰ O. Klauser,¹¹ S. Corbeels,¹² Celluloid Mfg. Co.,¹³ E. Löwenstein,¹⁴ B. Leu and V. Sjostrum,¹⁵ J. Lowe,¹⁶ J. Nichols,¹⁷ M. Nathanson,¹⁸ M. Lamy,¹⁹ A. Morelle,²⁰ M. McDonnell,²¹ E. Michaëlis,²² V. Montain,²³ E. Meeh,²⁴ A. Nowotny,²⁵ H. Pontanier and M. Moderne,²⁶ T. Pavlin,²⁷ P. Drake,²⁸ F. Reigter,²⁹ Rheinische Gummi und Celluloid Fabrik,³⁰ I. Shearer,³¹ F. Schaetz and B. Van Den Hoek,³² G. Smith and J. Stieglitz,³³ I. Schwarzer,³⁴ A. Savastano,³⁵ V. Schülmers,³⁶ J. Noyes,³⁷ L. Schwob and G. Herbert-

1911; 61603, 1913; F. P. 442640, 1912; abst. Kunst. 1913, **3**, 57.

32. U. S. P. 896373, 1908.

33. E. P. 24205, 1901.

1. U. S. P. 199909, 1878; 299390, 1884; 299389, 1884.

2. Kunst. 1914, **4**, 61, 84, 111; abst. C. A. 1914, **8**, 1667.

3. Kunst. 1913, **3**, 281, 303.

4. U. S. P. 1010913, 1911.

5. U. S. P. 613145, 1898.

6. U. S. P. 1027419; abst. Kunst. 1912, **2**, 476.

7. U. S. P. 308880, 1884.

8. U. S. P. 680050, 1901.

9. U. S. P. 699516, 1902.

10. F. P. 424738, 1911.

11. U. S. P. 870463, 1908.

12. E. P. 2312, 1877.

13. E. P. 878, 1878.

14. E. P. 10021, 1912; abst. Kunst. 1913, **3**, 453.

15. U. S. P. 712691, 1902.

16. U. S. P. 257033, 1882.

17. U. S. P. 902317, 1908.

18. U. S. P. 956091, 1910.

19. E. P. 21404, 1907.

20. E. P. 13528, 1898.

21. U. S. P. 874789, 1907.

22. E. P. 20220, 1899.

23. F. P. 433071, 1911.

24. D. R. P. 176578, 1905; 198154, 1906. Aust. P. 36750, 1908.

25. Aust. P. 63222, 1913.

26. F. P. 458590, 1913; abst. Kunst. 1914, **4**, 137.

27. Aust. P. 11509.

28. E. P. 2057, 1881.

29. U. S. P. 955089, 1910.

30. E. P. 19758, 1912. F. P. 339685, 1904. D. R. P. 142923; abst. Wag. Jahr. 1903, **46**, II, 570; 136153, 165988; abst. Wag. Jahr. 1906, **52**, II, 526. Aust. P. 9545, 1902; 15077, 1903; 61607; abst. Kunst. 1914, **4**, 56.

31. E. P. 3569, 1910.

32. Aust. P. 39963, 1909.

33. U. S. P. 823555, 1906.

34. U. S. P. 918203, 1909.

35. U. S. P. 857113, 1907.

36. E. P. 9268, 1911; abst. Kunst. 1912, **2**, 394; E. P. 15829, 1911; 25131, 1913; abst. Kunst. 1914, **4**, 273.

37. E. P. 10470, 1899.

Dilette,¹ Soc. Indust. de Cellulose,² Societe Anonyme Petitcollin,³ Thomas and Crasser,⁴ J. Torque,⁵ A. Talobre and E. Bertrand,⁶ J. Voiturin,⁷ P. Vernaz,⁸ O. Vallendar,⁹ Societe Vuagnat & Gaget,¹⁰ G. Wells and The British Xylonite Company, Ltd.,¹¹ J. Woods,¹² J. Burghoff and J. Wilks,¹³ G. Winn and A. Bates,¹⁴ V. Wilson,¹⁵ J. Wilcox,¹⁶ J. Walbridge,¹⁷ F. Wieland,¹⁸ and H. Zinn.¹⁹ It may readily be conceded from the above that an immense amount of thought and experimentation have been expended upon this subject in bringing it to its present high degree of perfection.

The pyroxylin plastics are used extensively in the formation of medallions,²⁰ portfolio,²¹ pie. orandum tablet,²² pocket book,²³ tooth brush case,²⁴ reservoir device,²⁵ dishes,²⁶ and similar receptacles, as soap dish,²⁷ soap holder²⁸ and soap tablet float,²⁹ and for similar purposes according to the inventions of H. Miller,³⁰ A.

1. F. P. 359001, 1905.
2. F. P. 319542, 319926, 1902; abst. J. S. C. I. 1902, **21**, 1550.
3. F. P. 402624, 1908.
4. D. R. P. 183163, 1905.
5. E. P. 2255, 1906. D. R. P. 187605; abst. Wag. Jahr. 1907, **52**, II, 561.
6. F. P. 462126, 1913.
7. F. P. 443043, 1912, abst. Kunst. 1913, **3**, 57.
8. F. P. 377913, 1907.
9. U. S. P. 756545, 1904.
10. F. P. 412710, 1910.
11. E. P. 14016, 1909, abst. J. S. C. I. 1910, **29**, 875.
12. U. S. P. 1003568, 1911.
13. U. S. P. 1029488; abst. Kunst. 1912, **2**, 439.
14. U. S. P. 735043, 1903.
15. U. S. P. 252856, 1882.
16. U. S. P. 951497, 1910.
17. U. S. P. 258170, 1882.
18. U. S. P. 1092881, 1092883, F. P. 406094, abst. Kunst. 1915, **5**, 70, 95.
19. U. S. P. 764697, 1904.
20. C. Levy, F. P. 406149, 1908.
21. A. Ryder, E. P. 13188, 1905.
22. W. Haseler, E. P. 10568, 1905.
23. W. and W. Hay, E. P. 20285, 1905.
24. A. Spencer, U. S. P. 368027, 1887.
25. L. Hymans, E. P. 24033, 1910.
26. C. Thurber and C. Schaefer, U. S. P. 542452, 1895. F. Nickerson, U. S. P. 251924, 1882; J. S. C. I. 1882, **1**, 147. See also Photographic Work, 1892, **2**, 222. Amat. Phot. 1898, **27**, 27; 1899, **30**, 374; 1900, **31**, 414, 454; 1901, **33**, 18.
27. B. Seemann, E. P. 12359, 1912.
28. F. Loring, E. P. 26738, 1903. F. Milligan, U. S. P. 539698, 1895.
29. A. Grice, E. P. 3763, 1905.
30. U. S. P. 610630, 1898.

Hafely and J. Redlefsen,¹ Societe Anonyme le Carbone,² G. Whiting,³ J. Wilcox,⁴ B. Slade,⁵ K. Collins,⁶ J. Lefarge,⁷ and J. Trayne.⁸ Powder puffs,⁹ jar covers,¹⁰ transparent packages,¹¹ manicure instruments,¹² massage combs¹³ and nail polishers¹⁴ have all been constructed of this plastic cellulose ester material.

Various moldable substances have from time to time been suggested as substitutes for ivory,¹⁵ and other rare and costly materials, but it was not until 1866¹⁶ that pyroxylin entered into their composition.¹⁷ The first dependable results obtained were by the use of compressed bone dust in the formation of "Bonsilate" by the Hyatts.¹⁸ In 1883 the first patent was issued for simulating the peculiar structure of real ivory by a plastic.¹⁹

1. U. S. P. 505462, 1892.
2. F. P. 321651, 1902; abst. J. S. C. I. 1903, **22**, 298.
3. U. S. P. 232095, 1880.
4. U. S. P. 1244676, 1917.
5. E. P. 23092, 1910.
6. U. S. P. 405874, 1889. E. P. 15189, 1888.
7. E. P. 2508, 1862.
8. E. P. 27288, 1910.
9. Soc. C. Michel, F. P. 434362, 1911.
10. F. Reddaway and M. Dessau, E. P. 9679, 1901.
11. H. Trotter, E. P. 18404, 1902.
12. M. Taussig, E. P. 27756, 1904.
13. H. Traun, E. P. 27837, 1913.
14. T. Miller, U. S. P. 900758, 1908. A safety razor, the holder, handle and wedge of which are made of celluloid is described by A. Bryant, Can. P. 184063, 1918.
15. S. Barbier and C. Coiffier, E. P. 441, 1883. C. Dupper, U. S. P. 51109, 1865. J. Frauenberger, U. S. P. 153939, 1874. J. Hackert, U. S. P. 42942, 1864. B. Harrass, D. R. P. 3008, 1878. L. Held, U. S. P. 17931, 1857. C. Homan, Belg. P. 136654, 1898. I. Hyatt, E. P. 1476, 1881. W. King, U. S. P. 648415, 1900. C. Lockwood and J. Hyatt, U. S. P. 305205, 1884. A. Ninet, Chem. Tech. Rep. 1863, **2**, II, 64. C. Peck and F. Engelhardt, U. S. P. 65425, 1867. W. Sanderson, U. S. P. 146481, 1874. A. Starr, U. S. P. 75067, 1868. A. Starr and W. Welling, U. S. P. 78842, 1868. D. and A. Staigt, U. S. P. 149615, 1874. J. Thornton and C. Rothwell, E. P. 4237, 1899. G. Tooker, U. S. P. 452869; abst. J. A. C. S. 1891, **13**, 174; Chem. Tech. Rep. 1891, **30**, I, 123. W. Welling, U. S. P. 17949, 1857; 77038, 1868; Re. 5940, 1874; 89100, 89531, 89532, 1869. C. Wolff, E. P. 3285, 1878. F. Cottrell, E. P. 220, 1882; abst. Chem. Ind. 1883, **6**, 49.
16. A. Parkes, E. P. 2709, 1866.
17. J. Stevens, U. S. P. 300158, 1884. S. Barbier and C. Coiffier, E. P. 441, 1883. A. dePont, E. P. 383, 1887. A. and S. dePont, and H. and I. Storey, E. P. 21561, 1891. I. Hyatt, E. P. 1476, 1477, 1881. A. MacFarlane and H. Stanbury, E. P. 3678, 1898. G. Mowbray, E. P. 7651, 1885. Bull. de la Soc. Fran. de Phot. 1877, **23**, 11. Chem. Centr. 1878, **49**, 831; abst. Amer. J. Pharm. 1879, **51**, 325. Proc. Amer. Pharm. Assoc. **40**, 536; Drug. Circ. 1891, 272. Cosmos, 1908, **56**, 222.
18. U. S. P. 133229, 1872; 156354, 1874; 236034, 1880; 239794, 1881; abst. J. S. C. I. 1882, **1**, 217.
19. J. Edson, U. S. P. 283225, 1883; 307032, 309831, 1884. E. P. 3930,

The de Pont patents first issued in 1887,¹ those of J. Hyatt in 1869,² and later,³ while the F. Cottrell process was first described in 1881.⁴

Other relatively less important refinements have been made with pyroxylin plastics in the hands of I. Appletree,⁵ D. Blake,⁶ E. Batonnier and P. Michel,⁷ T. Best,⁸ A. de Coetlogon,⁹ J. Clouet,¹⁰ G. Davey,¹¹ T. Didier,¹² E. Fischer,¹³ F. Greening,¹⁴ S. Hahn,¹⁵ H. Ligny,¹⁶ G. Mowbray,¹⁷ L. Merriam,¹⁸ C. Marter,¹⁹ W. Plinatus,²⁰ Soc. Anon. L'Oyonnaxienne,²¹ and Reuleaux.²² The manufacture of artificial horn from moldable nitrocellulose is based primarily upon the processes of G. Davey,²³ W. Harvey²⁴

- 1883; abst. J. S. C. I. 1884, **3**, 376; E. P. 17045, 1884. D. R. P. 27918, abst. Wag. Jahr. 1884, **30**, 1204. D. R. P. 37903, 1886. Cosmos, 1886, **3**, 446.
1. A. dePont, E. P. 383, 1887. A. and S. dePont, Can. P. 40502, 1892. A. and S. dePont and H. and I. Storey, E. P. 9267, 1880, abst. J. S. C. I. 1890, **9**, 540; E. P. 21561, 1891. Chem. Tech. Rep. 1891, **30**, I, 122.
2. U. S. P. 89582, 1869.
3. I. Hyatt, E. P. 1476, 1477, 1480, 1881. D. R. P. 16413, 1881. J. Hyatt, U. S. P. 88633, 1869; 201348, 1878; 239794, 1881. J. and I. Hyatt, U. S. P. 156352, 156353, 156354, 1874. J. S. C. I. 1882, **1**, 217. J. Hyatt and D. Blake, U. S. P. 89582, 1869. J. Hyatt, C. Lockwood and J. Stevens, U. S. P. 236034, 1880.
4. F. Cottrell, U. S. P. 254280, 1882, E. P. 3376, 1881.
5. E. P. 18090, 1889; abst. J. S. C. I. 1890, **9**, 199.
6. E. P. 1603, 1869.
7. E. P. 2326, 1880.
8. E. P. 15121, 1884.
9. N. Erfind. Erfahr. 1892, **19**, 57.
10. Bull. Soc. Ind. Rouen, 1877, 182; abst. Dingl. Poly. 1877, **224**, 646; Deut. Ind. Ztg. 1877, 396; Wag. Jahr. 1877, **23**, 1017. See also Wag. Jahr. 1875, **21**, 693.
11. E. P. 1443, 1872; 2832, 1877; abst. Chem. Centr. 1878, **49**, 640, Ber. 1878, **11**, 1390. See also Davey, Bickford, Watson & Co., Span P., Dec. 7, 1877; abst. Wag. Jahr. 1878, **24**, 466.
12. E. P. 22245, 1904. F. P. 336970, 1903; abst. J. S. C. I. 1904, **23**, 453; First Addn. 3879, dated Oct. 28, 1904 to F. P. 336970.
13. Kunst. 1916, **6**, 101, 116; abst. C. A. 1916, **10**, 1268.
14. U. S. P. 401269, 400944, 1889; E. P. 2481, 1883; 8442, 1886; 5344, 1889. F. Greening and J. Frost, F. P. 184247, 1887; Belg. P. 77879, 1887. F. Greening, O. Peck and T. Potts, Can. P. 30807, 1889.
15. E. P. 33, 1883. D. R. P. 25535; abst. Wag. Jahr. 1884, **30**, 1204, Chem. Tech. Rep. 1884, **23**, 108; Industriell. 1884, 183.
16. F. P. 386846, 1907.
17. U. S. P. 320884, 1885. E. P. 7651, 1885.
18. E. P. 10765, 1884; abst. J. S. C. I. 1885, **4**, 507.
19. E. P. 6142, 1908.
20. F. P. 465047, 465048, 1913; abst. J. S. C. I. 1914, **33**, 558.
21. F. P. 320123, 1902; abst. J. S. C. I. 1903, **22**, 104.
22. Gewerbebl. Württemberg, 1878, **28**, 41, 203; abst. Jahr. Chem. 1878, **31**, 1175.
23. E. P. 1443, 1872.
24. U. S. P. 460080, 1891; abst. J. A. C. S. 1891, **13**, 242.

and A. and E. Bishop.¹ The processes of Chemische Fabrik Heidenau,² A. Rowe,³ T. Guilford,⁴ H. Blücher and E. Krause,⁵ Offenbacher Celluloid Fabrik,⁶ F. Nickerson,⁷ and Schreiner & Sievers⁸ all employ some form of pyroxylin.⁹

Celluloid is especially suitable for the preparation with dyestuffs, fish scales and pigments, of that peculiar nacreous, iridescent appearance of real pearls, and G. Mowbray,¹⁰ O. Thiele,¹¹ K. Wirth¹² and Compagnie Francaise du Celluloid¹³ have described processes for so doing.¹⁴ Small amounts of inorganic sulfides to impart phosphorescence and a dichroic fluorescence in dim light has been advocated by I. Drummond.¹⁵ The L. Clemandot process¹⁶ contains no nitrocellulose.¹⁷

In the simulation of red or precious coral, pyroxylin plastic is mixed with tin and gold chlorides,¹⁸ barium sulfide,¹⁹ or other pigments,²⁰ or an impression of a piece of coral is obtained, and celluloid molded on a plaster cast made therefrom.²¹ Casein has also been used for this purpose.²² I. Hyatt²³ imitates meerscham

1. E. P. 24634, 1893.
2. D. R. P. 273958, 1911; abst. C. A. 1914, **8**, 3103.
3. E. P. 21708, 1912.
4. U. S. P. 256476, 1882.
5. E. P. 11563, 1915; 106270, 1917; abst. C. A. 1916, **10**, 99, 1917, **11**, 195, 2604. Cf. C. A. 1914, **8**, 76; E. P. 76, 1914.
6. D. R. P. 71204; abst. Ber. 1893, **26**, 1030. D. R. P. 67912; abst. Chem. Tech. Rep. 1898, **32**, I, 144.
7. U. S. P. 251924, 1882.
8. D. R. P. 71204; abst. Wag. Jahr. 1893, **39**, 1118.
9. In this connection see H. Arledter, E. P. 16085, 1912. R. Dodd and H. Humphries, E. P. 15316, 1913; abst. C. A. 1915, **9**, 132. E. Jetter, U. S. P. 749297, 1904; Belg. P. 169302, 1903. F. Kleinstuber, E. P. 14334, 1895. C. Lockwood, D. R. P. 27658, 1883. L. Nottelle and L. Leroux, E. P. 23619, 1904. R. Pioget, E. P. 106448, 1917; abst. C. A. 1917, **11**, 2604. W. Welling, U. S. P. 98272, 1870. G. Lincoln, U. S. P. 412398, 1889. J. Ind. Eng. Chem. 1913, **5**, 608. Kunst. 1912, **2**, 139.
10. U. S. P. 294661, 1884.
11. E. P. 13823, 1894.
12. D. R. P. 88442, 1895; abst. Ber. 1896, **29R**, 891.
13. F. P. 324894.
14. Zts. Drechsler, 1903, **26**, 362. Kunst. 1915, **5**, 24, 240.
15. U. S. P. 248413, 1881. See also F. P. 324894, 1902.
16. E. P. 954, 1877.
17. See Max de Nansoutty, "La Tabletterie, Os, Ecaille, Nacre, Celluloid."
18. D. Smith, U. S. P. 150722, 1874.
19. F. Cottrell, E. P. 220, 1882.
20. G. Davey, E. P. 1443, 1872.
21. L. Boule, A. Blin and E. Testu, E. P. 3703, 1878. J. Hornell, E. P. 20901, 1906.
22. J. Frauenberger, U. S. P. 182431, 1876.
23. E. P. 5240, 1878.

by utilizing the fragments with nitrocellulose and camphor as a binder, while A. v. Unruh¹ has detailed the various meerscham substitutes which have been advocated from time to time.

In the imitation of tortoise shell, celluloid—of all substances—is best adapted to this purpose. D. Spill² was the first to describe a process for pyroxylin tortoise-shell manufacture, the method of E. Schmidt³ being comparatively recent. The Schreiner & Sievers patent⁴ is said to have been successfully worked in Germany. The inventions of H. Beyer,⁵ R. Piogety⁶ and G. Tatham, et al.,⁷ contain no cellulose esters.

In addition to combinations of formaldehyde with casein,⁸ phenol⁹ and resorcinol¹⁰ for the fabrication of synthetic amber, copal¹¹ and pyroxylin¹² have been employed. In the reproduction of marble, ground and polished stone, the nitrocellulose plastics play an important part, as is evidenced by the processes of J. France,¹³ H. Engel,¹⁴ I. Traube,¹⁵ G. and C. Gornitzka,¹⁶ and A. Blitz.¹⁷ The essence of the M. May patent is casein,¹⁸ while the products of W. Anthony,¹⁹ L. Pfaffinger,²⁰ H. Garvey,²¹ C. Volek-mann²² and J. Elliot²³ contain no form of cellulose ester; J.

1. Kunst. 1916, **6**, 212, 229; abst. C. A. 1917, **11**, 1281.
2. E. P. 1739, 1875.
3. E. P. 23852, 1907.
4. D. R. P. 67912; abst. Wag. Jahr. 1893, **39**, 1119.
5. E. P. 11527, 1896.
6. U. S. P. 1263284, 1918; abst. C. A. 1918, **12**, 1590.
7. G. Tatham, D. Blair, C. Westwood and J. Dunkin, E. P. 28453, 1913.
8. N. Tarugi and G. Cioni, Boll. chim. farm. 1900, **58**, 101; abst. J. S. C. I. 1919, **34**, 427A.
9. L. Redman, U. S. P. 1107703, 1914; abst. J. S. C. I. 1915, **34**, 40.
10. H. Peter, U. S. P. 1147264, 1915; abst. C. A. 1915, **9**, 2435.
11. J. Bahret, D. R. P. 257065, 1911; abst. C. A. 1913, **7**, 2489; J. S. C. I. 1913, **32**, 499; Kunst. 1913, **3**, 389.
12. K. Micksch, Kunst. 1916, **6**, 191; abst. C. A. 1917, **11**, 1319. See also *Materialienkunde für den Kautschuk Techniker*, 1906, 61.
13. U. S. P. 602159, 603526, 1898.
14. E. P. 28361, 1911; abst. J. S. C. I. 1913, **32**, 87; C. A. 1913, **7**, 1064.
15. E. P. 15907, 1906.
16. E. P. 400, 1911. See also S. Hamilton, U. S. P. 269817, 1882.
17. E. P. 1874, 1901. See also A. Peter, U. S. P. 1147264; abst. C. A. 1915, **9**, 2433.
18. E. P. 8428, 1889.
19. D. R. P. 30470, 1884.
20. D. R. P. 31945, 1884.
21. U. S. P. 94736, 1889.
22. U. S. P. 97004, 1889.
23. U. S. P. 128218, 1872.

Stevens and E. Harrison¹ were the first to successfully imitate onyx and chalcedony with celluloid, most beautiful effects being produced.

The fabrication of mosaic, cloisonne and champleve enamel with celluloid was made possible and commercially successful through the inventive ingenuity of E. Harrison and C. Thurber,² J. France,³ H. Jorgensen,⁴ and W. Underwood.⁵ The H. Fritsch process is for "Email-Cloisssonne."⁶ An entirely original application of celluloid masses is in the sophistication of jet, the original process of G. Hirst having been disclosed in 1884,⁷ that of E. Heusch⁸ being of more recent date. Hyatt's original process for the formation of ebony masses was to mix tannin with the pyroxylin and camphor, then an alcoholic solution of ferric chloride, or hematoxylin and an iron salt. The surface may be given a dead finish⁹ by means of a sand blast. From the above indications, it may be seen what an exceedingly imitative and artistic industry has been made of the celluloids.

Celluloid Balls. In the manufacture of *hollow* balls of celluloid, for playing such games as ping pong, great rigidity with extreme lightness are the desirable factors aimed at. Thin halves are moulded, one with a projection or collar to fit over the other half, union being made permanent by means of a small quantity of celluloid lacquer. The process of H. Boetticher,¹⁰ A. Breinl,¹¹ F. Crane,¹² H. Dover,¹³ L. Delle,¹⁴ A. Dencede,¹⁵ D. Denny,¹⁶ P. Durand,¹⁷ A. Fleck,¹⁸ J. Hyatt,¹⁹ F. Harris,²⁰ H. Hay,²¹

1. U. S. P. 546360, 1895.

2. U. S. P. 602159.

3. U. S. P. 619637.

4. F. P. 363150, 1906. See also Zts. Dreschler, 1906, **29**, 131.

5. Aust. P. 60897; abst. Kunst. 1914, **4**, 454.

6. H. Fritsch, E. P. 11836, 1913. See also E. Jacob, F. P. 367484, 1906.

7. E. P. 503, 1884.

8. F. P. 417670, abst. Kunst. 1911, **1**, 90.

9. Rhein. Gummi und Celluloid Fabrik, D. R. P. 109738, abst. Wag. Jahr. 1900, **46**, 11, 565; Jahr. Chem. 1900, **46**, 850.

10. D. R. P. 63839, abst. Wag. Jahr. 1892, **38**, 1066.

11. E. P. 15888, 1890.

12. E. P. 7718, 1901.

13. E. P. 60, 1902.

14. E. P. 246, 1889.

15. E. P. 4920, 1892.

16. E. P. 4377, 1905.

17. F. P. 463149, abst. Kunst. 1914, **4**, 294.

18. E. P. 1283, 1893.

R. Hatton,¹ P. Hunacus,² F. Haynes,³ P. Klopsch,⁴ C. and E. Kingzett,⁵ J. Misko,⁶ G. Moore,⁷ Neumann and Marx,⁸ J. Newbold,⁹ S. Page,¹⁰ Rhein Gummi & Celluloid Fabrik,¹¹ C. Stanley and A. Warburton,¹² Stubling,¹³ J. Snyder,¹⁴ Soc. Petitecollin,¹⁵ F. Smith,¹⁶ E. Wood,¹⁷ and R. Wingfield¹⁸ are illustrative. Occasionally the balls have a light weight filler incorporated, in order to extend their carrying power when batted.

The manufacture of billiard balls, as has been mentioned, constituted one of the earliest successful attempts to prepare pyroxylin plastics of commercial suitability, and perhaps the Hyatt billiard ball¹⁹ was the first real success in this field. Billiard balls are usually made of ground bone or ivory or other composition having as nearly as possible the density and resilience of natural ivory. This mixture is agglutinated with celluloid hydraulically with heat, then turned and polished.²⁰ The processes of G. Burt,²¹ D. Blake,²² J. Bell,²³ L. Deitz, B. Wayne and A.

- 19 U. S. P. 138254, 1873
- 20 E. P. 20825, 1897
- 21 E. P. 11577, 1911
- 1 E. P. 24938, 1895
- 2 E. P. 15868, 1890, 10675, 1892, abst. J. S. C. I. 1892, **11**, 935
- 3 E. P. 4982, 1902
- 4 U. S. P. 1203747, 1916, abst. C. A. 1917, **11**, 191
- 5 U. S. P. 878070, 1908
- 6 Amer. Mach. 1902, **25**, 1690
- 7 E. P. 18853, 1906
- 8 D. R. P. 63822, abst. Wag. Jahr. 1892, **38**, 1066
- 9 U. S. P. 890920, 1908
- 10 E. P. 17318, 1903
- 11 D. R. P. 50008, abst. Wag. Jahr. 1890, **36**, 1178, Chem. Tech. Rep. 1890, **29**, 1, 114 D. R. P. 73665, abst. Chem. Tech. Rep. 1891, **33**, 1, 141, Wag. Jahr. 1894, **40**, 1108, Ber. 1894, **27**, 679.
- 12 E. P. 18821, 1895.
- 13 Celluloid, **7**, 99.
- 14 E. P. 17147, 1912, abst. Kunst. 1913, **3**, 295 D. R. P. 52775, abst. Wag. Jahr. 1890, **36**, 1178
- 15 E. P. 4369, 1902. See also British Xylonite, Ltd. and S. Bain; E. P. 3557, 1903
- 16 E. P. 4183, 1903.
- 17 E. P. 6940, 1890.
- 18 U. S. P. 797654, 1905. See also U. S. Customs Decision, June, 1903; abst. J. S. C. I. 1903, **22**, 934.
- 19 U. S. P. 50359, 1865, 76765, 1868, 88634, 1869, 92452, 1869, 114945, 1871.
- 20 Chem. Tech. Rep. 1878, **17**, 1, 227. Apoth. Ztg. **18**, 561. Min. and Sci. 1892, **65**, 238; abst. Manufacturer and Builder, 1893, **25**, 54, Encycl. Britannica, **15**, 95a.
- 21 U. S. P. 507880, 1893, 513876, 517972, 1894; 545578, 1895, 652993,

Stone,¹ A. and S. de Pont,² V. Hubbell,³ H. Haskell and C. Brigham,⁴ E. Kempshall,⁵ J. Patterson,⁶ G. Phelan,⁷ E. Roese,⁸ and J. White⁹ are based on the above method of procedure. The A. Labre¹⁰ and M. Hochgürtel¹¹ billiard chalk holder; the mounting of tips upon cues as in the processes of L. Hodson¹² and E. New,¹³ and W. Blight,¹⁴ are indicative of the trend of development in this direction.

An immense amount of ingenuity has been expended in the manufacture of an acceptable golf ball, as evidenced by the patents issued to E. Kempshall for celluloid¹⁵ and other¹⁶ golf

1900. A. Burt, D. R. P. 245108, 1909; abst. Kunst. 1912, **2**, 193.

22. E. P. 3651, 1868; 2510, 1869.

23. E. P. 26952, 1896.

1. U. S. P. 113272, 1871.

2. U. S. P. 502013, 1893.

3. U. S. P. 522792, 1894.

4. U. S. P. 753392, 1904.

5. U. S. P. 697925, 1902.

6. U. S. P. 426513, 1890.

7. U. S. P. 359032, 1887.

8. E. P. 5413, 1886. D. R. P. 36573, 1886.

9. E. P. 1876, 1906.

10. U. S. P. 363808, 1887. E. P. 1722, 1886.

11. E. P. 15673, 1907.

12. E. P. 11416, 1903.

13. E. New, E. P. 24411, 1899.

14. E. P. 20000, 1913.

15. U. S. P. 695813, 695866, 696365, 696366, 696367, 696368, 696886, 696887, 696888, 696890, 696891, 696892, 696893, 696894, 696895, 697418, 697419, 697420, 697421, 697422, 697423, 697424, 697425, 697917, 697918, 697920, 697921, 697924, 697925, 698401, 698512, 698513, 698515, 698516, 699087, 699088, 699089, 699090, 699094, 699623, 699624, 699876, 700123, 700144, 700655, 700656, 700657, 700658, 700659, 700660, 700943, 700944, 700945, 700946, 701736, 701738, 701739, 701741, 704463, 704464, 704748, 704838, 704882, 705249, 705764, 705766, 706758, 707595, 708484, 709411, 709412, 710198, 711508, 713771, 713772, 714917, 714918, 715206, 717413, 768129, 964524. E. P. 20296, 1901; 2052, 2302, 8982, 8984, 8985, 9240, 9242, 10453, 10704, 11319, 11507, 11752, 11754, 11755, 11996, 12054, 12468, 12475, 12477, 12479, 12480, 14975, 15156, 15157, 15158, 15800, 17144, 17181, 18221, 18505, 18588, 18589, 21109, 26070, 26259, 27989, 1902. F. P. 318198, 321437, 321438, 323529, 325509, 325790, 325794. D. R. P. 140145; abst. Wag. Jahr. 1903, **49**, 568. Can. P. 79695, 86417, 86418, 86419, 86420, 86421, 86422, 86423, 86424, 86425, 86426, 86427, 86428, 86429, 86468, 86469, 86470, 86471, 86472, 86473, 86474, 86475, 86476, 86477, 86478, 86479, 86480, 86617, 86643, 90560. Aust. P., Ann. 658, 1902. J. Nixon, E. P. 17132, 1905. See E. P. 3230, 1903.

16. U. S. P. 695866, 695867, 696369, 696889, 697417, 697919, 697922, 697923, 698024, 698402, 698514, 698517, 699091, 699092, 699093, 699622, 700124, 700942, 701737, 701740, 702799, 704462, 704881, 705359, 705765, 707425, 708483, 711215, 712387, 712388, 713769, 713770, 716245, 727542, 733216, 739753, 761590, 764598, 789694, 789695, 805470, 922773. E. P. 7935, 8406, 8409, 8802, 8803, 8804, 8983, 9241, 9243, 11754, 12462, 1902; 9469, 22267, 1908.

balls. The first Kempshall patent in this art appeared in 1901. Working in conjunction with F. Richards,¹ he so adjusted the weight, degree of elasticity, uniform density, light color and permanent resiliency as to produce a golf ball which was uniform throughout. The manufacture of golf balls is an important and highly specialized industry, as evidenced from the representative patented processes for their manufacture as issued to C. Davis² and with F. Kniffen,³ H. Armitage,⁴ J. Armstrong,⁵ J. Archibald,⁶ C. Boutwood,⁷ E. Buckau,⁸ G. Browning and C. Boutwood,⁹ J. Brand,¹⁰ British Xylonite Co. and S. Bain,¹¹ A. Breinl,¹² T. Bartlett,¹³ C. De Buren,¹⁴ T. Crawford,¹⁵ R. Cavanagh,¹⁶ J. Cochrane,¹⁷ Cambridge Manufacturing Company,¹⁸ W. Currie, Jr.,¹⁹ H. Dover,²⁰ M. Dessau,²¹ Dunlop Rubber Co. and J. Worthington,²² A. Denecede,²³ L. Delle,²⁴ W. Dunn,²⁵ H. Fullarton,²⁶ A. Fleck,²⁷ C. Gray,²⁸

1. U. S. P. 696353, 696354, 697926, 699632, 699813, 700155, 701617, 701765, 701766, 711230, 720482, 720737, 727199, 727201, 727202, 737773, 808683. E. P. 8410, 8802, 11650, 1902. Can. P. 86415, 86416, 86465, 86466, 86468, 86618. For other Richards golf ball patents, see U. S. P. 696351, 696352, 696879, 697927, 700154, 703000, 709360, 710368, 711177, 711178, 711227, 711228, 711229, 711529, 711530, 712411, 712412, 712413, 712414, 712415, 712416, 714950, 715295, 716347, 716348, 716349, 721462, 721463, 725011, 727198, 727200, 737774, 758851, 780582, 790398, 791648, 791649, 791946, 801813, 849572, 851377. E. P. 8407, 8408, 1901, 11605, 11606, 11607, 11657, 15159, 1902.
2. U. S. P. 697816, 703230, 736229, 736230, 736231, 736232, 736233, 790054, 790055, E. P. 152, 1902, Can. P. 86492.
3. U. S. P. 1202490, 1916.
4. E. P. 22115, 1891.
5. E. P. 11990, 1911. See also F. Harvey, Can. P. 142508, 1912.
6. E. P. 6917, 1891.
7. U. S. P. 737698, 1903.
8. U. S. P. 1034585, 1912. See also A. Johnston, Can. P. 144184, 1912.
9. U. S. P. 726502, 726503, 726504.
10. E. P. 19763, 1891.
11. E. P. 3557, 1903.
12. E. P. 15888, 1899, Aust. P. 1691, 1900.
13. E. P. 24534, 1902.
14. U. S. P. 786343, 1905; E. P. 23002, 1903, 11244, 1904.
15. U. S. P. 757600, 1904; E. P. 24232, 1902.
16. U. S. P. 710750, 710751, 710752, 710753, 710754, 710755, 1902.
17. U. S. P. 703896.
18. E. P. 16982, 1903.
19. E. P. 10701, 1890, 5731, 1891.
20. E. P. 60, 1902. See also C. Crest, U. S. P. 749053 and A. Cramer, U. S. P. 734256, 1903.
21. U. S. P. 951756, 1910.
22. E. P. 5581, 1911.
23. E. P. 4920, 1892.
24. E. P. 246, 1899.

T. Goddard,¹ M. Greenburg,² H. Hoffman,³ A. Hackett,⁴ W. Hillman,⁵ R. Hatton,⁶ R. Hutchison,⁷ J. Jerrard,⁸ C. Jacobs,⁹ C. Kingzett,¹⁰ C. and E. Kingzett,¹¹ C. Kingzett and F. Lovegrove,¹² Kleinert Rubber Co.,¹³ R. Knight and W. Peck,¹⁴ H. Lee,¹⁵ G. Lewis,¹⁶ J. Macneil,¹⁷ L. Du Mahaut,¹⁸ P. Meyer,¹⁹ D. Macpherson,²⁰ P. Martin and J. Stanley,²¹ F. Mingay,²² J. Murray and A. Levack,²³ A. Nixon,²⁴ K. Painter,²⁵ W. Park,²⁶ J. Paton,²⁷ L. Peterson,²⁸ A. Pitman,²⁹ A. and S. de Pont,³⁰ A. Powell,³¹ C. Porter,³² R. Reach and G. Staples,³³ C. Reade,³⁴ J. Ross,³⁵ J. Roger,³⁶ C.

25. W. Dunn, U. S. P. 745044, 1903; E. P. 5080, 1904.
26. E. P. 10043, 1913.
27. E. P. 1283, 1893.
28. E. P. 20253, 1901; D. R. P. Anm. G. 35606, 1911.
1. E. P. 18233, 1895.
2. E. P. 4591, 1903.
3. U. S. P. 1251029, Gummi Ztg **28**, 835, 878, abst. C. A. 1914, **8**, 1679.
4. E. P. 25674, 1912. See also F. Harris, E. P. 20825, 1897.
5. E. P. 12590, 1894; 4891, 1897.
6. E. P. 24938, 1895. See also P. Hunaeus, E. P. 10675, 1892; E. P. 20871, 1912.
7. U. S. P. 730126, 730127, 1903, abst. J. S. C. I. 1903, **22**, 809.
8. E. P. 24274, 1898.
9. E. P. 12019, 1894.
10. U. S. P. 734462, 734463, 1903; E. P. 22368, 1902; 2399, 1903; 28152, 1903; 16924, 1904.
11. E. P. 12073, 1906.
12. E. P. 10014, 1903.
13. E. P. 17318, 1903.
14. U. S. P. 676506, 1902. See also C. Davis and F. Kniffen, U. S. P. 1202490.
15. U. S. P. 805476, 1908.
16. E. P. 2235, 1896.
17. E. P. 17555, 1904.
18. U. S. P. 790252, 1905.
19. E. P. 3356, 1902.
20. E. P. 14414, 1894.
21. U. S. P. 1022248, 1912.
22. U. S. P. 889709, 1908.
23. E. P. 11917, 1895.
24. E. P. 17132, 17132 A, 1905.
25. U. S. P. 719689, 719498, 730050, 731406, 732583; E. P. 6705, 6706, 6707, 12717, 14764, 1903; Can. P. 84981, 84985.
26. E. P. 16862, 1890.
27. E. P. 13603, 1912.
28. U. S. P. 1185432, 1916.
29. U. S. P. 172482, 1876.
30. E. P. 3653, 1895.
31. E. P. 14062, 1908.
32. E. P. 15632, 1905; 16050, 1906.
33. U. S. P. 731614, 1903.
34. U. S. P. 879981, 1908; E. P. 21640, 1906.
35. E. P. 13830, 1891.
36. U. S. P. 743105, 1903.

Royce,¹ E. Smith,² F. Smith, Jr.,³ W. Smith,⁴ A. Smith, H. and J. Roberts,⁵ H. Singer,⁶ W. Short,⁷ J. Shepherd,⁸ L. Selzer,⁹ A. Saunders,¹⁰ E. Schultz,¹¹ A. Seaman,¹² F. Seiberling,¹³ Self Developing Plate Co. and T. Bolas,¹⁴ Societe Petticolin,¹⁵ W. and H. Southon,¹⁶ A. Spear,¹⁷ C. Stanley and A. Warburton,¹⁸ J. Stevens and C. Thurber,¹⁹ J. Stocker,²⁰ R. Schupphaus,²¹ W. Taylor,²² M. Lloyd,²³ W. Thomas,²⁴ C. Thompson,²⁵ W. Thomson,²⁶ E. Thurlow,²⁷ C. Treadwell,²⁸ J. Unwin,²⁹ R. and E. Urquhart,³⁰ F. Wadsworth,³¹ R. Wilson,³² E. Wood,³³ W. Wood and T. Bartlett,³⁴ and G. Worthington.³⁵

Celluloid has also been used in the construction of golf clubs³⁶ and hockey sticks,³⁷ and for golf ball cleaners.³⁸ Rubber

1. U. S. P. 925389, 1909, E. P. 20019, 1906.
2. E. P. 22161, 1897.
3. U. S. P. 720852, 726471, 1903, E. P. 1183, 1903.
4. E. P. 26103, 1898.
5. E. P. 9390, 1901, 8628, 1905.
6. U. S. P. 728411, 1903.
7. U. S. P. 737031, 1903.
8. E. P. 7615, 1903.
9. U. S. P. 716945, 1902.
10. U. S. P. 707263.
11. U. S. P. 716290, 716291, 1902.
12. U. S. P. 730303, 1903.
13. U. S. P. 786524, 1905.
14. E. P. 21880, 1907, abst. J. S. C. I. 1908, **27**, 1081.
15. E. P. 4369, 1902.
16. E. P. 28750, 1902.
17. U. S. P. 712610, 712611, 723938.
18. E. P. 18821, 1895.
19. U. S. P. 713168, 1902.
20. E. P. 3412, 1905.
21. U. S. P. 1208410, abst. C. A. 1919, **13**, 1956.
22. U. S. P. 878254, 1908.
23. E. P. 8201, 1891.
24. U. S. P. 809034, 809035, 1906.
25. U. S. P. 731821, 1903.
26. E. P. 16925, 1908.
27. U. S. P. 880342, 1908.
28. E. P. 23264, 1910.
29. E. P. 2129, 1905.
30. U. S. P. 776368, 1904, E. P. 336086, 1903.
31. U. S. P. 1182604, 1182605, 1916. See also C. Watkins, U. S. P. 715186, 1902.
32. E. P. 10859, 1905.
33. E. P. 6940, 1890.
34. E. P. 24534, 1902.
35. U. S. P. 972313, 1910.
36. M. Drummond, E. P. 5368, 1894.
37. W. Grenville, E. P. 4398, 1903.
38. C. Moxon and J. Brand, E. P. 21593, 1893.

and other composition balls may be painted with celluloid lacquer¹ and thereby materially increase the life and usefulness of the ball.

In the manufacture of games, toys and puzzles, celluloid often enters as in dominoes,² chess,³ quoits and discus,⁴ as well as bats and racquets for tennis and ping pong,⁵ hockey,⁶ cricket,⁷ and lacrosse.⁸ Pyroxylin plastic racquets and bats have been described by W. Quaife,⁹ W. Gabbey,¹⁰ J. O'Neil¹¹ and E. Gaskell.¹² The puzzles of J. Unwin,¹³ J. Boig¹⁴ and A. Phare¹⁵ are constructed wholly or partially of this material, as is also the toys evolved by E. Lehmann,¹⁶ Zelluloidkammfabrik in Prag, Brüder Lux,¹⁷ A. Wormald,¹⁸ J. Moret,¹⁹ F. Haynes,²⁰ R. Biewend,²¹ A. d'Denny,²²

1. J. Page, E. P. 19854, 1893. In this connection reference is made to E. P. 3710, 4165, 7631, 8567, 8663, 10805, 1900; 3482, 6348, 7718, 8069, 11446, 11887, 15058, 15452, 20253, 20296, 23846, 26155, 1901; 152, 1804, 2302, 4369, 7935, 8406, 8407, 8408, 8409, 8410, 8802, 8803, 8804, 8982, 8983, 8984, 8985, 9240, 9241, 9242, 9243, 10704, 11319, 11507, 11605, 11606, 11607, 11752, 11753, 11754, 11801, 11996, 12462, 12468, 12475, 12477, 12479, 12480, 14975, 14976, 15156, 15157, 15158, 15159, 15800, 15856, 17144, 17181, 17301, 18505, 18588, 18589, 19127, 21129, 22172, 22368, 22729, 24232, 24534, 26155, 26259, 27217, 27989, 28750, 1902; 2049, 2399, 3230, 4183, 4591, 6332, 6705, 6706, 6707, 7162, 7521, 8583, 9331, 10014, 10247, 11656, 11657, 11785, 12059, 12717, 12858, 13277, 13368, 14764, 16128, 16336, 16800, 16982, 17318, 18266, 18770, 18385, 23002, 24062, 28152, 1903; 374, 1463, 1712, 4960, 6172, 8072, 8697, 9281, 9330, 9773, 11240, 13118, 13929, 14701, 16378, 16924, 17208, 26831, 29396, 1904; 3412, 5547, 8986, 10859, 15632, 17132, 17132-A, 17186, 18068, 18695, 20005, 21595, 23252, 25607, 25658, 26743, 1905; 1984, 9299, 10463, 10779, 12073, 12272, 13088, 13718, 14284, 16050, 19981, 21640, 24720, 25349, 28085, 28424, 28425, 1906; 845, 852, 1139, 1310, 2458, 2641, 3559, 3577, 3641, 6566, 6872, 6928, 7296, 16006, 17560, 20892, 21340, 22379, 1907; 261, 2829, 3187, 3816, 7196, 8113, 9068, 10066, 16042, 16199, 16925, 18298, 19920, 22267, 1908; 9093, 16030, 21537, 26148, 1909; 364, 3781, 17392, 1910, 1512, 2195, 4022, 6603, 8557, 21740, 23525, 1911; 654, 13541, 20871, 24471, 1912; 680, 26401, 28195, 1913; 18, 17158, 1914; 11569, 103811, 1915.

2. M. Stein and J. Freud, E. P. 1347, 1896.

3. C. Whelpton, E. P. 8027, 1894.

4. J. Simons, E. P. 18716, 1902.

5. F. Ayres, E. P. 10097, 1894. R. Brand, E. P. 9015, 1890, Golf Club.

6. W. Grenville, E. P. 4398, 1903.

7. C. Paget, E. P. 9697, 1892.

8. H. Broomfield, E. P. 23325, 1912.

9. E. P. 27559, 1897.

10. E. P. 1111, 1902.

11. E. P. 18214, 1889.

12. E. P. 5354, 1894.

13. E. P. 9104, 1905; 2129, 1905.

14. E. P. 5635, 1897.

15. E. P. 18989, 1905.

16. E. P. 21373, 1902.

17. Aust. P. Ann. A. 4139, 1911.

18. E. P. 2177, 1893.

19. E. P. 26388, 1908.

20. E. P. 4982, 1902.

M. Dessau,¹ E. Thunderbolt,² A. Smith, H. and J. Roberts,³ F. Meyer,⁴ J. Williams,⁵ A. Lundström,⁶ J. Davenport,⁷ and J. Parker.⁸ To this list may be added spinning tops,⁹ indian clubs,¹⁰ drawing slates,¹¹ ballons,¹² fishing line,¹³ and thread¹⁴ reels, bicycle pedals,¹⁵ small boats,¹⁶ kaleidoscopes,¹⁷ go-carts,¹⁸ baby comforters and soothers¹⁹ and tubular skeleton frame handles.²⁰ Especial ingenuity and study has been brought to bear in the use of these plastics in the manufacture of playing cards and card games as exemplified in the patents of J. Hyatt,²¹ N. Hart and R. Bacon,²² R. Hoh & Co.,²³ J. France,²⁴ M. Winkelströter, A. Leisegang, and P. Simons,²⁵ J. Kohn and S. Strauss,²⁶ A. Leisegang, M. Winkelströter and P. Simons,²⁷ A. Neumann and L. Zuckerbaecker²⁸ and S. Neugroschl.²⁹

In the manufacture of dolls, either one-piece or articulated, celluloid has played an important part, especially in Germany where this branch has been brought to an enviable state of perfection. This is amply illustrated in the processes as described

21. E. P. 14862, 1894.
22. E. P. 4377, 1905.
1. E. P. 3345, 1905.
2. E. P. 19978, 1904.
3. E. P. 9390, 1904, 8628, 1905.
4. E. P. 21500, 1907; see also J. Furman, U. S. P. 426120, 1890.
5. E. P. 6089, 1907.
6. E. P. 7861, 1906.
7. E. P. 15872, 1885.
8. E. P. 7292, 1905.
9. F. Meyer, E. P. 21500, 1907.
10. M. Cronin, E. P. 11218, 1895.
11. R. Fraser, E. P. 21514, 1899. R. Wormald, E. P. 2177, 1893.
12. Rubber Balloon Co., E. P. 8593, 1903.
13. W. Carpenter, U. S. P. 368277, 1887.
14. J. Fuller, E. P. 10681, 1913.
15. U. S. P. 622243, 1899.
16. C. Pitman, U. S. P. 291533, 1884.
17. W. Whitlock, E. P. 12060, 1899.
18. J. Wilkinson and J. Fitzgerald, E. P. 20984, 1894.
19. E. Mincher, E. P. 6656, 1895.
20. J. Price, E. P. 19602, 1893.
21. U. S. P. 218122, 1878.
22. U. S. P. 241004, 1881.
23. E. P. 1286, 1905.
24. E. P. 17691, 1888; abst. J. S. C. I. 1889, 3, 303.
25. E. P. 20197, 1895.
26. E. P. 3364, 1892.
27. E. P. 13773, 1896.
28. E. P. 15442, 1891.
29. E. P. 14977, 1891.

by W. Carpenter,¹ M. Lefferts and W. Carpenter,² L. Vangel,³ Societe Francaise Pour La Fabrication De Bebes-Jouets,⁴ F. Scott and A. Seymour,⁵ Vereinigte Spielwarenfabriken,⁶ Buschow and Beck,⁷ W. Heincke,⁸ K. Standfuss,⁹ B. Goldenberg,¹⁰ F. Eaton,¹¹ W. Thompson,¹² J. Kubelka,¹³ W. Nuttall and J. Maden,¹⁴ E. Reinhardt,¹⁵ and F. Eaton.¹⁶ Heads, arms, bodies, joints and eyes are all profitably constructed of this ester, being difficultly breakable, light, sanitary and inexpensive.

The pyroxylin plastics for many years have found extensive employment in the manufacture of musical instruments, as in instrument keys,¹⁷ music clips,¹⁸ meloharp picks¹⁹ and plectrums,²⁰ banjo²¹ and violin tailpieces,²² and violin mutes,²³ but especially for piano and similar keys,²⁴ present day methods of preparation being based upon the processes of W. Zeidler,²⁵ and his co-worker, A. Newell,²⁶ J. Hyatt,²⁷ and J. Loose.²⁸ There should also be mentioned in this connection, analogous devices of C. Whitney,²⁹ D. Spurgeon,³⁰ U. Pratt,³¹ W. Richardson,³² R. Johnson,³³ S. Hogg-

1. U. S. P. 235933, 1880.
2. U. S. P. 237559, 1881.
3. Chem. Tech. Rep. 1879, **18**, II, 133.
4. F. P. 440520, 1911.
5. U. S. P. 508770, 1893.
6. D. R. P. Anm. V. 9115, 1909.
7. D. R. P. 162856, 1904.
8. U. S. P. 688640, 1901.
9. D. R. P. 137891, 1903; abst. Wag. Jahr 1903, **49**, II, 570.
10. U. S. P. 1010042, 1911.
11. E. P. 24846, 1904.
12. E. P. 6855, 1895.
13. E. P. 13084, 1887.
14. E. P. 21052, 1893.
15. E. P. 18089, 1904.
16. E. P. 24846, 1904.
17. L. Fuller, U. S. P. 483378, 1892.
18. W. Pike, U. S. P. 385642, 1888.
19. G. Shearer, U. S. P. 566806, 1896.
20. D. Barnes, U. S. P. 753534, 1904.
21. R. Benary, U. S. P. 334734, 1886.
22. E. Albert, U. S. P. 330185, 1885.
23. J. Mitchell, U. S. P. 885067, 1908.
24. Orgelb. Ztg. **4**, 224.
25. U. S. P. 373001, 1887; E. P. 8012, 1885; abst. J. S. C. I. 1885, **4**, 609; Can P. 21636, 1885; 28080, 1887; 38397, 1892.
26. U. S. P. 300725, 1884; 423075, 423076, 1889; Can P. 38382, 1892.
27. U. S. P. 210780, 1878.
28. U. S. P. 683956, 1901. E. P. 20168, 1901.
29. U. S. P. 477830, 1892.
30. U. S. P. 796878, 1905.
31. U. S. P. 190363, 1877.

son and G. Pettis,¹ L. Fuller,² G. French,³ and also J. Decker.⁴

Celluloid in Phonography. Undoubtedly the most important use of pyroxylin plastics in this connection is in the talking machine industry, where there is hardly a portion of the entire instrument in which celluloid has not at one time or another been employed. This exceedingly highly specialized industry owes in a large measure its advancement to the employment of celluloid. Belt and tape records,⁵ phonograph boxes,⁶ coated fiber,⁷ record shrinking,⁸ cylinder collapsing,⁷ record blanks,¹⁰ records,¹¹ helically wound¹² and cylinder records,¹³ diaphragms,¹⁴ disc records,¹⁵ single and double¹⁶ faced, molding,¹⁹

- 32 U. S. P. 569032, 1896
- 33 U. S. P. 217111, 1879
- 1 U. S. P. 274328, 1883
- 2 U. S. P. 463986, 1891
- 3 U. S. P. 251212, 1881
- 4 J. and W. Decker, E. Winkler, P. Friess and A. Werner, U. S. P. 497426, 1893
- 5 U. S. P. 397856, 399264, 399265, 695159, 728867 E. P. 11608, 1890, 10357, 1891, 2690, 8248, 1893, 9606, 1902, 4680, 1905, 6220, 18057, 1906, 17168, 1907 F. P. 7983, 8134, 319469, 364414, 375429
- 6 E. P. 19562, 1906
- 7 E. P. 17163, 1902 F. P. 338849, Addn. 2694, 2767, 1903
- 8 U. S. P. 528273, 645920, 672909, 689117, 689118, 689408, 692337, 728607, 735579, 742454, 742455, 750118, 836417, 881644 E. P. 1560, 1561, 13344, 1900, 7146, 23386, 1902, 16283, 1903 F. P. 326171 Can. P. 67854
- 9 U. S. P. Re-issue 11917, 650431, 672909 E. P. 1478, 1894
- 10 U. S. P. 750119, 773978, 999183 E. P. 18917, 1902, 14071, 14073, 1907, 24723, 1909
- 11 E. P. 4052, 1900, 11908, 11909, 1903, 27952, 27953, 1906 U. S. P. Re-issue 13067, 666493, 666819, 683979, 689117, 689408, 692337, 771758, 800331, 822485, 837927, 846411, 854886, 854887, 881644, 892301, 951483, 960320 F. P. 332336, 372538, 372539 Can. P. 123818, 123819
- 12 U. S. P. 939119, 939120 E. P. 24693, 24723, 1909 Can. P. 123818, 123819 D. R. P. 229412
- 13 U. S. P. 399264, 399265, 528273, 645920, 649385, 650431, 650739, 657956, 664223, 666493, 666819, 666937, 667600, 672909, 683962, 683979, 689117, 689118, 689408, 689706, 692337, 705772, 708828, 710209, 713209, 728607, 728867, 735579, 736773, 739713, 742454, 742455, 750118, 750119, 771758, 773978, 800331, 822485, 836417, 837061, 837927, 846411, 850256, 854886, 854887, 855555, 855556, 871554, 881644, 892301, 939119, 939120, 951483, 953454, 960320, 961980, 999183, 1018631, Re-issue 11917, and 13067 E. P. 23366, 1893, 1478, 1894, 15057, 22867, 1899, 1560, 1561, 4052, 8930, 11469, 13344, 1900, 715, 926, 1901, 7146, 16833, 17163, 18917, 23386, 1902, 2009, 8649, 11908, 11909, 16283, 19163, 24382, 24382 A, 1903, 4680, 1905, 6613, 18057, 27952, 27953, 27954, 1906, 8840, 14071, 14073, 17168, 1907, 24693, 24723, 1909, 10319, 1910 D. R. P. 229412, 229715 Can. P. 67854, 70735, 123818, 123819 F. P. 230177, 326174, 332336, 332337, 336677, 364222, 372538, 372539, 372540, 375429, 378304 Re-issue 1365, 7983, 8134
- 14 E. P. 1497, 1906, 21087, 1907, 11015, 1909 F. P. 359148, 382200
- 15 U. S. P. 548623, 663194, 664223, 666493, 666819, 680321, 689118, 695159, 708828, 710209, 713209, 728867, 763564, 771758, 819058, 819072,

mandrel expanders,¹ folding cylindrical records,² shrinking records,³ phonograph horns,⁴ and sound boxes,⁵ hydrostatic record formers,⁶ combined synchronous cinematographic and phonograph devices,⁷ laminated records,⁸ plastic-metallic matrices,⁹ atmospheric,¹⁰ centrifugal¹¹ and embossed¹² pressure moulded records, expanding cylinder records,¹³ flowable cast records,¹⁴ with or without knurling them,¹⁵ vertical pressed records,¹⁶ mechanically expanded,¹⁷ segmentally expanded.¹⁸ Records hydrostatically¹⁹ or otherwise

- * 832403, 838068, 840932, 847338, 862407, 878547, 897254, 903199, 992169. E. P. 23366, 1893; 22867, 23497, 1899, 4052, 20710, 1900; 715, 22709, 24183, 1901; 9906, 17163, 1902, 1992, 8649, 16445, 16446, 19163, 1903, 28784, 1904, 16129, 1905; 6220, 6613, 17767, 18057, 1906, 14098-A, 18250, 1907; 4953, 1909; 24552, 1910. F. P. 230177, 319469, 332181, 332184, 336677, 364222, 364414. Can. P. 79800, 136378. D. R. P. 203924.
- 16. U. S. P. 819072, 862407, 878547.
- 17. U. S. P. 672909, 728607, 735579. E. P. 7146, 1902.
- 1. U. S. P. 850256, 966771. D. R. P. 229379, 229837. F. P. 332336, 378304. Can. P. 114758, 123820, 131425. E. P. 11908, 24382, 24382-A, 1903; 8840, 1907, 25342, 25361, 1909.
- 2. U. S. P. 850256. F. P. 378304. E. P. 24382-A, 1903; 8840, 1907.
- 3. G. Stevens, U. S. P. 667600.
- 4. U. S. P. 663011, 673396, 692363, 805544, 805600, 820926. F. P. 360612. E. P. 7594, 1900; 17786, 1902; 24880, 1904; 7543, 18318, 24117, 1905.
- 5. U. S. P. 673396, 805544, 805600, 820926. F. P. 321507, 360613, Can. P. 75281. E. P. 7594, 1900; 9727, 22273, 1901; 17786, 1902; 7543, 24117, 1905.
- 6. U. S. P. 650431, 735579, Re-issue 11917. E. P. 7146, 1902.
- 7. E. P. 18057, 1906.
- 8. U. S. P. 664223, 666819, 689117, 689408, 713209, 763564, 771758, 819058, 819072, 847338, 862407, 878547, 897254. F. P. 332181, 332184, Can. P. 136378. E. P. 16445, 16446, 1903, 4680, 1905; 17707, 1906; 18250, 1907.
- 9. A. Petit, U. S. P. 736773, 739713.
- 10. F. Capps, U. S. P. 689536, 871554.
- 11. U. S. P. 689117, 689408, 692337, 855555, 855556, 951483, 953454. E. P. 4680, 1905.
- 12. I. Kitsee, U. S. P. 903199.
- 13. U. S. P. 649385, 650739, 689536, 713209, 871554, 881644. E. P. 15057, 1899; 17168, 1907. F. P. 375429, Addn. 7983, 8134.
- 14. U. S. P. 666819, 666493, 683802, 683979, 689117, 689408, 692337. F. P. Addn. 1365 to 296351. E. P. 4052, 1900; 926, 1901.
- 15. U. S. P. 399264, 399265, 528273, 695159. F. P. 230177, 319469. E. P. 23366, 1893; 9906, 1902.
- 16. U. S. P. 528273, 713209, 763564, 819058, 819072, 840932, 847338, 862407, 878547, 897254, 992169. F. P. 230177, 332181, 332184, 336677. E. P. 23366, 1893; 23497, 1899; 8649, 16445, 16446, 1903; 17767, 1906; 14098-A, 18250, 1907. D. R. P. 203924.
- 17. U. S. P. 672909, 837061, 846411, 951483, 1018631. F. P. 332337, 336677. E. P. 1478, 1894; 8649, 11909, 1903.
- 18. W. Runge, U. S. P. 1018631.
- 19. U. S. P. 649385, 650431, 650739, 672909, 689117, 689118, 689408, 692337, 705772, 728607, 735579, 742454, 742455, 750118, 836417, 854887, 871554, 961980, Re-issue 11917. F. P. 326174, 372539, 375429, Addn. 7983,

expanded,¹ cut up and down ("hill and dale cut"),² photophono-grams (celluloid records made by light vibrations),³ celluloid plastics,⁴ postal card records,⁵ direct recording records,⁶ record shells,⁷ plastic faced records,⁸ primarily of sheets,⁹ or sheet-faced,¹⁰ reproducing needles,¹¹ resonators,¹² sound amplifiers¹³ and attenuators,¹⁴ solvent blank softening,¹⁵ as by nitrocellulose solutions,¹⁶ and sound modifiers.¹⁷ Transparent celluloid records,¹⁸ united

8134. E. P. 15057, 1899; 13344, 1900; 7146, 16833, 23386, 1902; 16283, 1903; 4680, 1905; 27953, 1906; 14071, 14073, 17168, 1907.

1. U. S. P. 662961. F. P. 326891, 335240, 347270, 370354, 375739, 375741, 382211. D. R. P. 190064, 203685. Can. P. 68305. E. P. 19956, 1906.

2. E. P. 23497, 1890.

3. U. S. P. 728867, 881664, 900706. F. P. 715, 1901; 18057, 1906.

4. U. S. P. 528273, 548623, 645920, 649385, 650431, 650739, 657956, 663194, 664223, 666937, 672909, 683862, 689118, 713209, 728607, 735579, 736773, 739713, 742454, 742455, 750118, 771758, 819072, 836417, 838968, 840932, 878547, 881644, 892301, 903199, 902169, Re. 11917. F. P. 230177, 326174, 336677, 338849, Addn. 2694, 2707. Can. P. 67854, 70735. D. R. P. 203924. E. P. 23366, 1893, 1478, 1894; 15057, 23497, 1899, 1560, 1561, 8930, 13344, 20710, 1900; 24183, 1901; 7146, 23386, 1902; 8649, 15490, 16283, 19163, 1903, 17767, 1906, 14071, 14073, 14098-A, 1907.

5. E. P. 28784, 1904; 16129, 1905.

6. U. S. P. 397856, 657956, 666937, 695159, 708828, 710299. F. P. 319469. Can. P. 70735. E. P. 22867, 1899; 8930, 11469, 1900, 9906, 1902, 28784, 1904.

7. U. S. P. 689117, 689408, 692337, 771758, 800331, 822485, 837061, 837927, 846411, 850256, 854886, 854887, 881644, 951483, 960320, 990183, Re-13067. F. P. 332336, 332337, 372538, 372539, 372540, 375429, 378304, Addn. 7983, 8134. D. R. P. 229715. E. P. 1478, 1894, 11908, 11909, 24382, 24382-A, 1903; 27952, 27953, 27954, 1906, 8840, 17168, 1907; 10319, 1910.

8. U. S. P. 666819, 683979, 689117, 689408, 692337, 763564, 819058, 847338, 862407, 878547, 897254, 951483. F. P. 332181, 332184, 338849, Addn. 2694, 2707. E. P. 17163, 1902; 1992, 16445, 16446, 1903; 17767, 1906, 18250, 1907, 4953, 1909. Can. P. 136378.

9. U. S. P. 399264, 399265, 686321, 695159, 763564, 819058, 832403, 847338, 854886, 862407, 897254, 903199, 951483, 960320, 992169, Re-13067. F. P. 319469, 332184, 372540, 375429, Addn. 7983, 8134. E. P. 9906, 1902, 16446, 1903; 27954, 1906; 17168, 18250, 1907.

10. E. P. 22709, 1901; 992, 1903; 16129, 1905, 6220, 1906. Can. P. 79890, 123819. F. P. 364414.

11. U. S. P. 870300. E. P. 12549, 1908.

12. U. S. P. 709984. E. P. 8011, 1906.

13. T. Macdonald and F. Capps, U. S. P. 865716.

14. U. S. P. 838968, 878547. E. P. 17767, 1906.

15. U. S. P. 397856, 645920, 657956, 664223, 666937, 672909, 689118, 708828, 710299, 728607, 837061, 846411. F. P. 332336, 332337. Can. P. 67854, 70735. E. P. 22867, 1899; 1560, 1561, 8930, 11469, 1900; 11909, 1903.

16. U. S. P. 666493, 689117, 689408, 692337, 855555, 855556, 953454. F. P. 338849, Addn. 1365, 2694, 2707. E. P. 926, 1901; 17163, 1902; 15490, 1903.

17. U. S. P. 867836, 876035. F. P. 371284. E. P. 5879; 1906.

18. U. S. P. 528273, 771758, 832403. E. P. 23366, 1893; 16129, 1905. F. P. 230177.

with¹ or without welding or molding² or hydraulically,³ afterwards expanded by heat⁴ and removed by cold,⁵ strip records,⁶ by no means exhaust the uses to which the pyroxylin plastics have been applied in this industry, or adequately convey a conception of the intricacy and detail involved in bringing the talking machine instrument to its present degree of perfection. Cellulose acetate⁷ and other cellulose esters⁸ have also been used in fashioning plastic records. Inventors of gastronomic propensities, have patented edible records made of chocolate,⁹ so that if a record for any cause should prove unsatisfactory to the aesthetic taste, there is another taste which may be satisfied.¹⁰

The detailed expansion of this subject is too ramified to be attempted here, but is fully treated in a topic in Volume V of this work. Those, however, interested in a more comprehensive knowledge should consult the original sources of information in the inventions of M. Adom,¹¹ C. Adams-Randall,¹² Aeolian Co.,¹³ American Graphophone Co.,¹⁴ F. Applegate,¹⁵ G. Archer,¹⁶ F. Armbruster,¹⁷ P. Aylsworth,¹⁸ H. Ballard,¹⁹ A. Bawtree,²⁰ A. Baci-

¹ U. S. P. 399264, 399265, 650431, 854886, 939119, 939120, 951483, 960320, Re- 11917, 13067. F. P. 372540, 375429, Addn. 7983, 8134. D. R. P. 229412, 229715. Can. P. 123818, 123819. E. P. 27954, 1906; 17168, 1907, 24693, 24723, 1909, 10319, 1910.

² U. S. P. 649385, 683979, 692337, 705772, 728607, 742455, 750118, 836417, 847338, 854886, 854887, 961980, 999183, 1018631, Re- 13067. F. P. 372539. E. P. 15057, 1899, 16833, 23386, 1902, 16283, 1903; 27953, 1906.

³ U. S. P. 649385, 692337, 705772, 728607, 742455, 750118, 836417, 854887. F. P. 372539. E. P. 15057, 1899, 16833, 23386, 1902; 27953, 1906.

⁴ U. S. P. 528273. E. P. 23366, 1893. F. P. 230177.

⁵ U. S. P. 692337, 728607, 742454, 750118, 836417. E. P. 23386, 1902; 16283, 1903.

⁶ U. S. P. 854886, 960320, Re- 13067. F. P. 372540. E. P. 27954, 1906, 10319, 1910. D. R. P. 229715.

⁷ U. S. P. 855556, 865716, 953454, 962877. E. P. 926, 1901; 13428, 1906, F. P. 338849, F. P. 367026, Addn. 1365, Addn. 2694, Addn. 2707.

⁸ U. S. P. 855556, 953454. E. P. 926; 1901. F. P. 338849, Addn. 1365, 2694, 2707.

⁹ E. Heimerdinger, E. P. 1902, 16445, 1903. F. P. 332181, 332182, 332183, 332184.

¹⁰ The foregoing data has been largely taken from the classification of George H. Stevens, the eminent American authority on this subject.

¹¹ U. S. P. 1202638, 1916, abst. C. A. 1917, **11**, 90.

¹² E. P. 10357, 1891, 2690, 8248, 1893.

¹³ E. P. 24120, 24135, 1911.

¹⁴ E. P. 4052, 1900; 17767, 1906; D. R. P. 203685, 1909; Can. P. 108703, 1907.

¹⁵ U. S. P. 939119, 939120, 1909, E. P. 24723, 1909; D. R. P. 229412, 1909; Can. P. 123819, 1910.

¹⁶ E. P. 27283, 1912.

¹⁷ E. P. 28784, 1903; F. P. 328221, 1903; Belg. P. 174524, 1903.

¹⁸ U. S. P. 855555, 855556, 871554, 1907; 953454, 1910; 1024965,

- galupi,¹ E. Berliner,² The Burt Co.,³ F. Capps,⁴ J. Challen,⁵ M. Claussen,⁶ F. Clay,⁷ W. Clifton and B. Oaksford,⁸ G. Clinchant, F. Desbriere and G. Vescier,⁹ Compagnie Francaise du Celluloid,¹⁰ Compagnie Generale de Phonographes, Cinematographes, et Appareils de Precision,¹¹ Continental Royal Phone and Phonogram Co.,¹² C. Cooke,¹³ J. Coombs,¹⁴ E. Cousens,¹⁵ J. Craig, Jr.,¹⁶ A. Defavrie,¹⁷ F. Desbriere,¹⁸ G. Downing,¹⁹ E. Dragoumis,²⁰ W. Duddell,²¹ T. Edison,²² B. Edwards,²³ A. Eichengrün,²⁴ W. Elliott,²⁵ T. Emery and W. Adkins,²⁶ V. Emerson,²⁷ 1036416, 1043389, 1046137, 1912, Re-13531, 1913, thereto, 1146384, 1916, 1170391, 1916; E. P. 9559, 1911; F. P. 429292, 1911, abst. J. S. C. I. 1911, **10**, 1267; 1913, **32**, 35, 298; Kunst 1913, **3**, 302, C. A. 1912, **6**, 1377, 2547, 2855; 1915, **9**, 2432, 1916, **10**, 958.
19. U. S. P. 985496, 1911.
 20. E. P. 4680, 1905.
 - 1 Ital. P. 87558, 1907, 91466, 1908, 104615, 1910, 112272, 1912.
 - 2 U. S. P. 548623, 1895. See also S. Brown, E. P. 1157, 1911.
 - 3 E. P. 16536, 1904; 7993, 1905, F. P. 347270, 1905, Addn. thereto 1701, 1905.
 - 4 U. S. P. 666493, 1901, 689536.
 - 5 U. S. P. 663011, 1900.
 6. E. P. 3334, 1913.
 7. U. S. P. 728867, 1903, 881664, 900706, 1908.
 - 8 E. P. 2099, 1903.
 9. E. P. 926, 1901, F. P. 296351, 1900, Addn. 1365, 1903, D. R. P. 112517, 1900.
 10. F. P. 333240, 1903. D. R. P. 156413, 1902, abst. Chem. Ztg. 1904, **28**, 1158. See also A. Defavrie, E. P. 19163, 1903.
 11. E. P. 12035, 1910, F. P. 391826, 1907.
 12. U. S. P. 939119, 939120, 1909, E. P. 24693, 24723, 25342, 25361, 1909; D. R. P. 229379, 229412, 229715, 229837, Belg. P. 220478, 220479, 220854, 1909, Can. P. 114758, 1908, 123818, 123819, 123820, 1910, 131425, 1911.
 13. E. P. 715, 1901.
 14. E. P. 21087, 1907, F. P. 382260, 1907.
 15. E. P. 1497, 1906.
 16. U. S. P. 992169, 1911, E. P. 13064, 1909.
 17. E. P. 19163, 1903, abst. J. S. C. I. 1904, **23**, 834.
 18. E. P. 926, 1901. F. P. 296351, Addn. 1365, 1903.
 19. E. P. 8840, 1907.
 20. E. P. 19956, 1906. F. P. 382211, 1907.
 21. E. P. 24546, 1902.
 22. U. S. P. 713209, 713863, 1902, 1078265, 1913, 1119142, 1914; 1146413, 1146414, 1915, 1207383, 1916; 1234450, 1248468, 1917; abst. J. S. C. I. 1902, **21**, 1541; C. A. 1914, **8**, 405; 1915, **9**, 2432, 2433; 1917, **11**, 280, 1918, **12**, 412. Can. P. 82572, 1903. D. R. P. 130033. T. Edison and J. Aylsworth, E. P. 507, 1913. U. S. P. 1342326, abst. C. A. 1920, **14**, 2244.
 23. E. P. 11945, 1890.
 24. E. P. 17574, 1912.
 25. E. P. 11668, 11669, 1890.
 26. U. S. P. 781137, 1905.
 27. U. S. P. 838968, 1906; 1113973, 1183358, 1916; 1341740; abst. J. A. 1920, **14**, 2244. Can. P. 102043. J. Ellis, W. Eickstedt, E. P. 18519, 1911.

J. Escamez and A. Moriones,¹ H. Fairbrother,² T. Flatau and F. Schellhorn,³ H. Framery and L. Pacaud,⁴ H. Godwin and A. Hoffman,⁵ B. Goldsmith,⁶ R. Grimoin-Sanson,⁷ R. Haines, J. Pletts, and E. Lauste,⁸ V. Harris,⁹ R. Head,¹⁰ E. Heimerdinger,¹¹ L. Helm,¹² G. Herrington,¹³ G. Hogan,¹⁴ G. Holden,¹⁵ W. How,¹⁶ W. Hoyt,¹⁷ H. James,¹⁸ J. Jones,¹⁹ Cie. Gen. des Phonographs Cinematographes et App. de Precision,²⁰ C. Krieger and G. Burt,²¹ I. Kitsee,²² T. Lambert,²³ H. Langston,²⁴ M. Lefferts,²⁵ S. Levin,²⁶ H. Lioret,²⁷ C. Loeschner,²⁸ L. Ludwig and E. Pfefferkorn,²⁹ L.

1. E. P. 17168, 21789, 21799, 1907. F. P. 370354, 375429, Addn. 7983, 8134, 375739, 375741, 1907. Belg. P. 202785, 1908. In this connection see E. P. 1644, 1878; 8248, 1893; 4680, 1905; 6220, 1906.
2. E. P. 17780, 1902.
3. E. P. 13428, 1906. F. P. 367026, 1906.
4. E. P. 8649, 1903. F. P. 336677, 1904. Belg. P. 167540, 1902.
5. U. S. P. 819058, 1906.
6. U. S. P. 840932, 1907. E. P. 14098-A, 1907. D. R. P. 203924.
7. Belg. P. 207073, 1908.
8. E. P. 18057, 1906.
9. U. S. P. 837061, 837927, 1906; 846411, 854886, 1907. Re. 13067, 1910, 854887, 1907; 860320, 1910. E. P. 11908, 11909, 1903; 27952, 27953, 27954, 1906. F. P. 332336, 332337, 372538, 372539, 372540, 1906. D. R. P. 149297, 1904; 190964, 1907. Belg. P. 170552, 170553, 1903; 196777, 196778, 196779, 1906.
10. U. S. P. 805544, 1905; 820926, 1906.
11. E. P. 16446, 1903. F. P. 332181, 332184, 1903. D. R. P. 152822, 1904. Belg. P. 170379, 170380, 170381, 1903.
12. E. P. 25217, 1907.
13. U. S. P. 397856, 399264, 399265, 1889.
14. U. S. P. 673396, 1901. E. P. 7594, 1900. D. R. P. 128950, 1902.
15. E. P. 7543, 1905.
16. U. S. P. 709984, 1902.
17. U. S. P. 847338, 1907; 897254, 1908. E. P. 18250, 1907. W. Hoyt and W. Gaven, U. S. P. 808842.
18. E. P. 27382, 1908.
19. U. S. P. 763564, 1904.
20. F. P. 358366, 1905; abst. J. S. C. I. 1906, **25**, 227.
21. E. P. 17163, 1902.
22. U. S. P. 903199, 1908.
23. U. S. P. 645920, 664223, 695159, 742454, 742455, 1900. E. P. 1560, 1561, 13344, 1900; 9906, 1902. F. P. 319469, 326174, 1902. D. R. P. 124752, 1901; 127119, 1902; 136447, 141268, 1903. Can. P. 67854, 1900. Belg. P. 164703, 1902. For litigation on above patents see Off. Gaz. 174, **8**, 31; Off. Gaz. 174, 1220. 125 F. R. 922. 60 C. C. A. 632. In this connection see T. Edison, U. S. P. 382418, 1888; 414761, 1889.
24. E. P. 18318, 1905.
25. U. S. P. 672909, 1901.
26. U. S. P. 870300, 1907.
27. U. S. P. 528273, 1894; 629273, 1899. E. P. 23366, 1893; F. P. 230177, 1893.
28. D. R. P. 115466; abst. Jahr. Chem. 1900, **53**, 850; Wag. Jahr. 1900, **46**, 11, 565. Aust. P. 7720, 1901.
29. E. P. 7624, 1889.

Lumiere,¹ T. Macdonald,² F. von Madaler,³ American Graphophone Co.,⁴ G. Manwaring,⁵ F. Matthews,⁶ B. Philpot⁷ and F. Matthews, W. Messer,⁸ H. Mikorey,⁹ J. Milans,¹⁰ W. Miller and A. Pierman,¹¹ J. Millet,¹² E. Mobley,¹³ W. Morton,¹⁴ O. Multhaupt,¹⁵ F. Myers,¹⁶ F. Myers and H. Smythe,¹⁷ A. Newman,¹⁸ Nicole Freres,¹⁹ W. Kaiser,²⁰ T. Opel,²¹ S. Paxton and C. Shigley,²² L. Pacaud and H. Framery,²³ F. Perkins,²⁴ A. Petit,²⁵ B. Philpot,²⁶ The Phonofilm Syndicate,²⁷ J. Pletts,²⁸ R. Revell and T. Barnard,²⁹ N. Reif,³⁰ V. Reko,³¹ J. Reynard,³² W. Runge,³³ F. Russell and

1. E. P. 11015, 1909; Aust. P. 16941, 1904. A and L. Lumiere, E. P. 15490, 1903, F. P. 338849; Addn. 2604, 2707, 1903.
2. U. S. P. 862407, 865716, 1907. 878547, 1908.
3. E. P. 23497, 1899; 19502, 1906. Belg. P. 116267, 1899.
4. E. P. 17767, 1906.
5. U. S. P. 819072, 1906.
6. U. S. P. 951483, 1910.
7. U. S. P. 802301, 1908.
8. U. S. P. 705772, 1902, 961980, 1910. E. P. 168263, 1902.
9. E. P. 24880, 1904.
10. U. S. P. 832403, 1906.
11. U. S. P. 785510, 790516, 1905.
12. U. S. P. 1047971, 1912.
13. F. P. 359148, 1905.
14. E. P. 3408, 1912.
15. E. P. 24183, 1901. Belg. P. 150971, 1901. Aust. P. 12113, 1903.
16. E. P. 18017, 1900.
17. U. S. P. 663194, 1900; 686321, 1901. E. P. 20710, 1900, 22709, 24509, 1901. D. R. P. 125469, 1902. Can. P. 79890, 1903.
18. E. P. 6220, 6613, 1906. F. P. 364222, 364414, 1906.
19. F. P. 326891, 1902.
20. Kunst. 1911, 1, 122.
21. E. P. 12549, 1908.
22. U. S. P. 800331, 1905, 822485, 1906.
23. E. P. 8649, 1903. F. P. 336677, 1904. Belg. P. 167540, 1902.
24. U. S. P. 850256, 1907. E. P. 8840, 1907. F. P. 378304, 1907. See also W. Runge, U. S. P. 850256, 1907. E. P. 24382, 24382-A, 1903.
25. U. S. P. 657956, 662961, 1900, 666937, 683862, 683979, 689117, 689118, 689408, 1901; 692337, 708828, 710239, 1902, 728607, 735579, 736773, 739713, 750118, 750119, 1904, 773978, 1904, 840932, 1907. E. P. 22867, 1899; 8930, 11469, 1900; 7146, 18917, 23386, 1902. 16283, 1903. D. R. P. 132732, 1901; 148682, 1904. Aust. P. 11697, 1902, 15112, 1903. Can. P. 68305, 1900; 70735, 1901.
26. U. S. P. 999183, 1911.
27. Can. P. 136378, 1911. Belg. P. 226126, 1910.
28. E. P. 15302, 1903.
29. U. S. P. 867836, 1907. R. Revell and T. Barnard, E. P. 5879, 1906. F. P. 371284, 1907.
30. U. S. P. 895197, 1908.
31. Kunst. 1914, 4, 323; abst. C. A. 1914, 3, 323.
32. U. S. P. 666819, 1901.
33. U. S. P. 692363, 1902; 850256, 1907; 906771, 1910, 1018631, 1912.

* E. P. 9727, 22273, 1901; 1803, 24382, 24382-A, 1903. F. P. 321507. Belg. P. 163518, 1902. Can. P. 75281, 1902.

A. Jung,¹ F. Seymour,² C. Shigley,³ D. Reed,⁴ Societe des Etablissements Gaumont,⁵ G. Stevens,⁶ F. Stock,⁷ Stollwerk Akt.-Ges. Gebr.,⁸ J. Szek and G. Schauli,⁹ W. Tyler,¹⁰ M. Thomas,¹¹ G. Hogan,¹² E. and B. Tröckmann,¹³ U. S. Phonograph Co.,¹⁴ E. Walker,¹⁵ C. Wickes,¹⁶ R. Winne,¹⁷ J. Whitman,¹⁸ H. Wolcott,¹⁹ C. Wurth,²⁰ J. Young,²¹ W. Young,²² and Excelsiorwerk Fabrik für Feinmechanik.^{23,24}

The efforts in investigation which ultimately lead to the production of commercial pyroxylin plastics in commercial quantities was in attempts to replace hard rubber in dentistry. In the introductory or formative period of this art—which may be said to include up to the year 1880, appeared the processes of L. Dobbins,²⁵ J. Duchesne,²⁶ T. Gibson,²⁷ J. Gartrell,²⁸ W. Gates,²⁹ R. Hunt,³⁰ H. Hamecher and C. Gebell,³¹ A. Hill,³² I. and J. Hyatt and J. Perkins,³³ Kirstein,³⁴ G. Morrison,³⁵ J. MacClelland,³⁶ J.

1. E. P. 14071, 14073, 1907.
2. E. P. 24552, 1910.
3. C. Shigley and S. Paxton, U. S. P. 800331, 1905, 822485, 1906.
4. E. P. 3542, 1867.
5. F. P. 394492, 1907, 400252, 1908.
6. U. S. P. 650431, 1900, Re. 11917, 1901, 667600, 1901.
7. E. P. 23386, 1903.
8. E. P. 1992, 1903.
9. E. P. 8011, 1906.
10. U. S. P. 836417, 1906.
11. E. P. 16129, 1905.
12. E. P. 7594, 1900.
13. E. P. 4953, 1909. F. P. 400051, 1909. Belg. P. 214380, 1909.
14. E. P. 10319, 1910. D. R. P. 229715, 1911. Belg. P. 109692, 225343, 1910.
15. U. S. P. 805600, 1905. E. P. 24117, 1905. F. P. 360613, 1906.
16. U. S. P. 1213051, 1917; abst. C. A. 1917, **11**, 877.
17. U. S. P. 881644, 1908.
18. U. S. P. 1030364, 1912.
19. U. S. P. 649385, 650739, 1900. E. P. 15057, 1899.
20. U. S. P. 771758, 1904.
21. E. P. 1478, 1894.
22. U. S. P. 876035, 1908.
23. E. P. 17827, 1909.
24. In this connection see G. Harrison, E. P. 10319, 1910. *Loude, Mon. Phot.* **20**, 74.
25. U. S. P. 222678, 1879. E. P. 12123, 1880.
26. E. P. 1728, 1881.
27. E. P. 2985, 1881.
28. E. P. 3986, 1877, 5112, 1878. D. R. P. 4007, 1878; 7380, 1879; abst. *Dingl. Poly.* 1880, **235**, 205.
29. U. S. P. 238382, 1881.
30. U. S. P. 133196, 1874.
31. D. R. P. 6927, 1879; abst. *Dingl. Poly.* 1880, **235**, 205.
32. U. S. P. 93086, 1869.
33. U. S. P. 113055, 1871. E. P. 1025, 1871. J. and I. Hyatt, U. S. P.

Macintosh,¹ C. Reagles,² J. Robie,³ A. Pursell,⁴ V. Smith,⁵ R. Telschow,⁶ V. Smith,⁷ J. Troutman,⁸ R. Winsborough,⁹ and L. and G. Winderling.¹⁰ From this time onward have been devised many refinements especially along the lines of prosthetic dentistry, as is evinced by the detailed descriptions of J. Albrecht,¹¹ H. Black,¹² R. Brewster,¹³ J. Brockway,¹⁴ J. Cannon,¹⁵ I. and A. Delatour,¹⁶ L. Eilertsen,¹⁷ C. Fritzsche,¹⁸ E. Fogg,¹⁹ T. Forster,²⁰ J. Graft,²¹ H. Hartwig and A. Feltmann,²² J. Housel,²³ V. Hartley,²⁴ H. Hamecher,²⁵ C. Hammersley,²⁶ W. Curtis,²⁷ W. Hough,²⁸ V. Hartley,²⁹ M. Carpenter,³⁰ W. How,³¹ A. Keightley,³² C. Leadbetter,³³ E. Locke,³⁴ C. Land,³⁵ R. Norman,³⁶ A. Meckel,³⁷ E. Mincher,³⁸

121522, 1871

34. D. R. P. 8008, 1879
35. U. S. P. 121802, 1871
36. U. S. P. 77304, 1868, Re. 3777, 3778, 1869, 76221, 1868, 90765, 1869, 125979. E. P. 2785, 1867, 536, 1868.
1. E. P. 2790, 1859
2. U. S. P. 173865, 1876.
3. U. S. P. 179667, 1876
4. U. S. P. 126575, 1872.
5. U. S. P. 127656, 1872
6. E. P. 2771, 1879, D. R. P. 8528, 1879, 11717, 1880
7. E. P. 2513, 1875
8. U. S. P. 120130, 1871.
9. U. S. P. 114242, 1871
10. E. P. 156, 1879
11. E. P. 2098, 1913
12. U. S. P. 1294355, 1919, abst. J. S. C. I. 1919, **38**, 283 A
13. U. S. P. 219382, 1879. E. P. 3300, 1878, D. R. P. 6512, 1879
14. U. S. P. 113736, 1871. E. P. 2892, 1870
15. U. S. P. 165303, 1875
16. E. P. 22010, 1894
17. U. S. P. 825268, 987451, 1911. E. P. 14475, 1900, 4440, 1903; 12203, 1905; abst. J. S. C. I. 1901, **20**, 704.
18. E. P. 12576, 1908
19. E. P. 25288, 1913.
20. E. P. 3178, 1871. ●
21. U. S. P. 750639, 1904.
22. U. S. P. 659747, 1900
23. U. S. P. 283487, 1883.
24. E. P. 548, 1899.
25. D. R. P. 6927
26. D. R. P. 26144; abst. Chem. Tech. Rep. 1884, **23**, 108
27. U. S. P. 374585, 1887.
28. E. P. 3296, 1913.
29. E. P. 548, 1899.
30. U. S. P. 256879, 1882
31. U. S. P. 276245, 1883.
32. U. S. P. 173647, 1876.
33. E. P. 19522, 1890.
34. U. S. P. 258858, 1882.
35. U. S. P. 271476, 1883.

G. Nawrocki,¹ G. Rutterfor & Son and J. Huntley,² J. Powell,³ C. Richmond,⁴ C. Rauhe,⁵ F. Seabury,⁶ A. Shirley and E. Horst,⁷ J. Schwieder,⁸ P. Schaefer,⁹ G. Shannon,¹⁰ J. Swasey,¹¹ L. Streeter,¹² S. Thomas,¹³ E. Telle,¹⁴ I. Warren and Dental Manufacturing Co.,¹⁵ F. Wienand,¹⁶ G. Weidhaas,¹⁷ J. Wedgwood,¹⁸ Z. Mertens,¹⁹ R. Winsborough,²⁰ and F. Wienand.²¹ H. McKay has described a celluloid toothpick case.²²

There is hardly a branch of surgery in which celluloid appliances have not been employed with advantage.²³ Intramuscular, intravenous, enema and artificial impregnation syringes are constructed of pyroxylin plastic, according to the designs of J. Pickford,²⁴ Parke, Davis and Co.,²⁵ M. Lefferts,²⁶ C. Huish,²⁷ G. Hughes,²⁸ A. Gordon and E. Spencer-Mason,²⁹ J. and H. Lie-

- 36 Deut. Zahnärztliche Wochen. Oct. 4, 1911; Dental Cosmos, 1912, **54**, 379.
37. E. P. 433950, 1911.
38. E. P. 6656, 1895.
1. E. P. 2771, 1879.
2. E. P. 18550, 1898.
3. U. S. P. 902109, 1908.
4. U. S. P. 277939, 1883.
5. E. P. 13153, 1904.
6. U. S. P. 271370, 1883.
7. E. P. 19764, 1892.
8. E. P. 9173, 1913.
9. Can. P. 127493, 1910.
10. Dental Cosmos, 1912, **54**, 229.
11. U. S. P. 301936, 1884.
12. U. S. P. 88228, 88260, 89253, 1868.
13. E. P. 17968, 1892.
14. E. P. 27970, 1908.
15. E. P. 22474, 1909, 9630, 1910.
16. E. P. 16071, 1893.
17. U. S. P. 880432, 1908.
18. E. P. 4128, 1883.
19. Zahnärztliche Rundschau, Feb. 8, 1914, abst. Dental Cosmos, 1914, **6**, 996.
20. U. S. P. 114242, 1871.
21. E. P. 16071, 1893.
22. H. McKay, U. S. P. 469064, 1892.
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ztg. 1899, **13**, 633.
24. E. P. 14278, 1903.
25. E. P. 9729, 1903.
26. U. S. P. 235953, 1880.
27. E. P. 15362, 1898.
28. E. P. 25150, 1906.
29. E. P. 134, 1895.

berg,¹ and G. Otto.² This applies likewise to the respirators, inhalers and stethoscopes of G. Clements,³ M. Dickinson,⁴ J. Lobjois,⁵ A. Keller,⁶ W. Richards,⁷ C. Teske,⁸ J. Woods,⁹ F. Wyeth,¹⁰ and G. Zimmer.¹¹ Vaccine, and wound-protecting shields and guards have been described by G. Beringer,¹² L. Denis,¹³ C. Heidemann,¹⁴ R. Johnson,¹⁵ G. Kemp,¹⁶ J. Lee,¹⁷ H. Mulford,¹⁸ Salzmann,¹⁹ and J. Steele and H. Stafford.²⁰

In ear and other hearing appliances, the apparatus of J. Williams,²¹ E. Brown,²² E. Little,²³ W. Haslam,²⁴ J. Cousins,²⁵ and E. Samson²⁶ are more frequently used, as well as the dress shields of S. Greene,²⁷ J. Sutcliffe²⁸ and I. Reade.²⁹ In trephining,³⁰ artificial limbs,³¹ foot-arch supports,³² trusses,³³ cupping,³⁴ plasters,³⁵ crutch top,³⁶ suture plate,³⁷ discharge-collecting vessels,³⁸ cata-

1. E. P. 2483, 1904. See also L. Cyrenius, Can. P. 198426, 1919.
2. U. S. P. 235958, 235959.
3. E. P. 11474, 1885.
4. E. P. 24150, 1912.
5. E. P. 21500, 1903.
6. E. P. 7699, 1913.
7. E. P. 25804, 1910.
8. E. P. 21939, 1897.
9. E. P. 6954, 1890.
10. E. P. 5432, 1894.
11. E. P. 27215, 1896.
12. U. S. P. 695270, 1902.
13. U. S. P. 652999, 1900.
14. U. S. P. 828311, 1906.
15. U. S. P. 720812, 1903.
16. E. P. 406, 1898.
17. U. S. P. 697637, 1902.
18. U. S. P. 703290, 1902.
19. Proc. Amer. Pharm. Assoc. **44**, 459, abstr. Amer. Druggist, 1896, 275.
20. E. P. 14555, 1895.
21. E. P. 10288, 1907.
22. E. P. 1437, 1905. See also E. P. 3164, 1860, 18824, 1893, 21670, 1895, 320, 1899; 18944, 1901.
23. E. P. 19494, 1891.
24. E. P. 16176, 1913.
25. E. P. 851, 1889.
26. E. P. 632, 1900.
27. E. P. 13932, 1899.
28. E. P. 6740, 1889.
29. E. P. 7772, 1892.
30. Dawbarn, Ann. Surg. April 1903.
31. W. Longmate, E. P. 3991, 17662, 1913.
32. H. Kapper, E. P. 30498, 1909.
33. J. Hibell, E. P. 15725, 1895.
34. J. Heywood, E. P. 18973, 1910.
35. H. Helbing and G. Pertsch, U. S. P. 628463; E. P. 25779, 1896.
36. J. Whittemore, U. S. P. 233824, 1880.

menial shields,¹ in correcting broken or deformed features,² suspensory bandage,³ antiseptic pencil,⁴ pads,⁵ instrument handles,⁶ clinical thermometer protectors,⁷ stammering and stuttering treatment,⁸ pus cups,⁹ pulmonary,¹⁰ rectal,¹¹ and massage appliances,¹² have all been produced wholly or in part of this material. The tampon introducers of S. Dayan,¹³ and W. Gibbins;¹⁴ speculums of G. Otto¹⁵ and O. Bernhardt;¹⁶ catheters according to A. Plisson¹⁷ and T. and W. Nicholls;¹⁸ tongue depressing¹⁹ and cleansing instruments of B. Buckmann²⁰ and Will & Finck Co., and M. Frederick;²¹ the pessaries of W. Brooksbank,²² W. Campbell²³ and C. Cannon;²⁴ together with X-ray apparatus of H. Lieber,²⁵ W. Martin²⁶ and H. Saunders and W. Craske²⁷ are indicative of the manifold uses to which these cellulose esters have been applied in the healing art. H. Lieber²⁸ protects radium surfaces by a pyroxylin coating.

The pyroxylin bandages and surgical dressings of H. Weidig,²⁹

37. O. Witherbee, U. S. P. 784018, 1905.
38. W. Browne, E. P. 27254, 1900.
1. H. Hudson, U. S. P. 794181, 1905. E. P. 14291, 1905.
2. J. Duchatellier, E. P. 6743, 1904.
3. A. Wells, E. P. 15782, 1889.
4. C. Swett, U. S. P. 1280580, abst. C. A. 1918, **12**, 2662.
5. W. Ray, U. S. P. 313238, 1885.
6. F. Nuessle, U. S. P. 361315, 1887.
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8. F. Knoch, E. P. 16045, 1906.
9. H. Iscovesco, E. P. 17233, 1890.
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11. J. Schwieder, E. P. 9173, 1913.
12. J. Heywood, E. P. 18973, 1910.
13. U. S. P. 393546, 1888.
14. E. P. 972, 1911.
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16. E. P. 23438, 1895.
17. E. P. 23589, 1911.
18. E. P. 2073, 1882.
19. J. Osborne, U. S. P. 412409, 1889.
20. U. S. P. 619466, 1899.
21. E. P. 13341, 1894.
22. E. P. 6418, 1888.
23. E. P. 3613, 1877.
24. U. S. P. 547625, 1895.
25. J. S. C. I. 1905, **24**, 230; Chem. Centr. 1905, **76**, I, 1213. See also radium surfaces on celluloid sticks, H. Lieber, E. P. 11926, 1905.
26. E. P. 24618, 1904.
27. E. P. 27357, 1904.
28. E. P. 11926, 1905.
29. U. S. P. 696123, 1902.

H. Wilson,¹ A. Wells,² F. Lefagnays,³ C. Henderson,⁴ and G. Sumner,^{5,6} the trusses of T. Salt⁷ and J. Hibell,⁸ and the celluloid surgical splints as devised by J. Peck,⁹ A. Sands,¹⁰ J. Peck,¹¹ M. Pollock,¹² and E. Jacob¹³ have played an important part in the setting of limbs and arms at the front in the late conflict. The inhaling apparatus of C. Cenarro¹⁴ is worthy of mention.

In 1905 appeared the work of L. de Labarthe on the use of celluloid in orthopedics,¹⁵ in which a comprehensive review of the subject is made. A. Fleischer,¹⁶ F. le Faguays¹⁷ and H. Kapper¹⁸ have introduced special apparatus for the rigid support of members of the body. In ophthalmology and otology, celluloid artificial eyes as made by the T. Fray¹⁹ and H. Hamecher²⁰ methods,

1. U. S. P. 917694, 1909
2. E. P. 15782, 1889
3. E. P. 15276, 1910
4. E. P. 12434, 1895
5. U. S. P. 737526, 1903
6. Jamm, *Technol.* 1880, **40**, 264. *Impr.* 1880, **17**, 107; *Archiv.* 1880, **17**, 211, 243, 245. *Gewerbebl. Wurt.* 1880, **32**, 310. J. Boeck, *J. Buchdr.* 1880, **47**, 690; *Printer*, 1880, **1**, 78. *Gumm. Ztg.* 1899, **13**, 633. *J. Buchdr.* 1900, **67**, 498. C. Lorch, *J. Buchdr.* 1901, **68**, 76; *Zts. Reprod.* 1901, **3**, 77. *Graph. Beob.* **8**, 771. *Impr.* **37**, 150. *Apoth. Ztg.* 1901, **22**, 121
7. E. P. 18741, 1896
8. E. P. 15725, 1895
9. E. P. 2425, 1913
10. Washington, D. C. *Evening Star*, February 6, 1918, page 18
11. E. P. 23777, 1912; *abst. J. S. C. I.* 1913, **32**, 1006
12. E. P. 10654, 1905
13. *Dental Cosmos*, 1912, **54**, 499
14. E. P. 13563, 1912
15. R. Barwell, *Inter. J. Surgery*, 1888, 137. F. Bedy, *Centr. f. orthop. Chir.* Oct. 1886. J. Bedy, *Centr. f. Chir.* 1888, No. 42. Bird-Golding, *Rev. d'orthop.* Paris, 1890, No. 1, 35. *Brit. Med. J.* May 13, 1882. Black, *Berl. Klin. Woch.* 1874, 534. B. Brodhurst, *Rev. d'orthopedie* 1891, 115. Calot, *Soc. de Chirurgie*, February, March 1899, Nov. 3, 1903. *Congress de Chirurgie* 1901. De Saint-Germain, *L'Union Medecale* 1882, No. 47. J. Finck, *Zts. f. orthop. Chirurgie* Stuttgart 1904, **24**, pt. 2, 3. Flaschar, *Centr. f. Chirur.* 1886, No. 43. Fourmer, Precey and Begu, *Orthopedie*, Paris, 1819, **38**. Hirsch, *Phil. Med. and Surg. Rep.* May 1885. Hoffa, *Centr. f. arzt. Polyt.* May 30, 1890. Jaffe, *Samm. Klin. Vert.* Dec. 28, 1899, No. 348. Kirmisson and Phocas, *Soc. Chir.* June 25, 1890. Menard, *Rev. Chir.* 1899, Jan. No. 1. Morton, *Phil. med. Times* Feb. 1883. G. Ryan, *Amer. Pract.* New, 26 Oct. 1889. Schwartz, *Wien. Med. Presse*, Sept. 30, 1888. Wittelschoffer, *Wien. Med. Presse*, 1887. Zabudowsky, *Berl. Klin. Wochschr.* 1886, No. 26, 28.
16. E. P. 5020, 1906
17. E. P. 15276, 1910. Belg. P. 226766, 1910
18. E. P. 20394, 1909. See also G. Batten, E. P. 7272, 1901.
19. *Pop. Sci. Monthly*, 1890, **37**, 575
20. E. P. 5068, 1884. D. R. P. 17272, 1881, 23822, 1882.

as well as artificial ears,¹ and the celluloid eye baths of J. Byrom² are interesting in this connection. In optics,³ nitrocellulose plastics have long been used for spectacle frames⁴ and in mathematical and astronomical instruments.

The printing upon and ornamenting celluloid, especially in display advertising, has of late years assumed ever increasing importance.⁵ The usual printing inks are worthless for this purpose, and special inks have been devised by J. Duquesney,⁶ F. Meyer,⁷ A. Bensinger,⁸ E. Newport,⁹ Rheinische Gummi and Celluloid Fabrik,¹⁰ J. Arns,¹¹ C. Josz,¹² T. Truchelut and A. Roche-reau,¹³ and E. Roehm.¹⁴ In monotone and polychromatic printing, engraving and embossing, highly artistic, permanent and inexpensive processes have been developed. Those interested in the details will find full information in the methods of G. Audres and C. Elliot,¹⁵ F. Annison,¹⁶ J. Arns,¹⁷ J. Atkinson,¹⁸ A. Bacigalupi,¹⁹ L. Baumann, G. Thesmar and S. Jones,²⁰ A. Bensinger,²¹ C. Brady,²²

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2. E. P. 21318, 1907. See also A. Andrews, E. P. 142240.
3. G. Leroy, *Bull. Soc. Rouen*, 1897, **25**, 386. For anti-dimming compound to prevent fogging of celluloid eyepieces of gas masks, see P. Carleton, *J. Ind. Eng. Chem.* 1919, **11**, 1105; abstr. *J. S. C. I.* 1920, **39**, 79-A.
4. J. Spencer, U. S. P. 220502, 1879.
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12. E. P. 11344, 1890.
13. E. P. 23826, 1899.
14. U. S. P. 791503, 1905.
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Millergraph Co.,¹ A. Mittelacher,² E. Newport,³ Deutsche Celluloid-Kunstdrucker,⁴ J. Paterson, W. Dickson and G. Kerr,⁵ Publishing, Advertising and Trading Syndicate,⁶ Rheinische Gummi and Celluloid Fabrik,⁷ R. Roehm,⁸ A. Rose,⁹ C. Rosier,¹⁰ Schumacher,¹¹ J. Shuttleworth,¹² C. Shaw and D. Sandemann,¹³ C. Smith,¹⁴ W. Smith and J. Isgrig,¹⁵ J. Stephan,¹⁶ F. Sommer,¹⁷ Sommer and Friedrich,¹⁸ R. Temmel,¹⁹ Usher-Walker and C. Sohn,²⁰ M. and G. Walker,²¹ H. Warne and C. Godfrey,²² E. Wilmhurst,²³ Soc. de la Manufacture d'Indiennes "Emile Zundel,"²⁴ Soc. Anon. Internazionale per i Cliches in Celluloide Bacigalupi,²⁵ and H. Ziegler-Reinacher.²⁶

In reproduction technic, cellutype, cellulotype,²⁷ cliches, printing blocks and in the multitudinous branches of the graphic arts, celluloid is daily playing a more important rôle. Celluloid stamps, factitious lithographic stones, writing slates, stereotypes, intaglio plates,²⁸ are comprehended in this category. As illus-

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trative of the general trend of thought and experimentation in this direction, may be cited the discoveries and contributions of Adam,¹ N. Amstutz,² C. George,³ A. Bacigalupi,⁴ A. Balagmy,⁵ Beitlich,⁶ A. Bensinger,⁷ V. Bluthgen,⁸ C. Lorch,⁹ David,¹⁰ J. Brunner and C. Klary,¹¹ E. Busse,¹² D. Cameron-Swan,¹³ Capitaine and von Hertling,¹⁴ C. Chisholm,¹⁵ W. Cooper,¹⁶ G. Fischer,¹⁷ W. Gamble,¹⁸ J. Arnold,¹⁹ G. and A. Gornitzka,²⁰ F. Hanson,²¹ P. Hodgkinson,²² M. Imbert,²³ L. Jannin,²⁴ G. Kraft,²⁵ A. Jarman,²⁶ A. Jensen,²⁷ C. Josz,²⁸ G. Koppmann,²⁹ T. Kohler,³⁰ Kraft,³¹ S.

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Kristensen,¹ M. Lefferts and J. Hyatt,² D. Lichtenberg-Madsen,³ L. Marc,⁴ G. Munday and V. Evans,⁵ I. Nelson and J. Murray,⁶ T. Ninnis,⁷ O. von Volkmer,⁸ Partridge,⁹ C. Rosier,¹⁰ I. Rubie and J. MacManus,¹¹ Schelte and Giesecke,¹² J. Schmidting,¹³ Soc. Anon. Petitcollin,¹⁴ Sperling,¹⁵ T. Stagg,¹⁶ J. Stevens,¹⁷ F. Sommer,¹⁸ T. Truchelut and A. Rochereau,¹⁹ E. Vogel,²⁰ O. Volkmer,²¹ Aktienges. f. Anilin Fabrikation,²² and H. Ziegler-Reinacher.²³

Celluloid in Photography. In the almost endless photographic processes which have been brought forward from time to time, these compounds enter to a large degree. At this time can be but briefly skeletonized those processes in which celluloid enter in contradistinction to the non-plastic nitrocelluloses. Sensitized films, magic lantern slides, kineoscopic pictures, printing paper, transfers, film supports, photo screens, diaphragms have all been prepared from celluloid.²⁴

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* Details of these processes are contained in the writings and descriptions of Actiengesellschaft f. Anilin Fabrikation,¹ W. Adams,² W. Kerkow,³ M. Anthes,⁴ C. Archer,⁵ A. Barratt and A. Hill,⁶ M. Bauer,⁷ A. Baumgartner,⁸ E. Benedictus,⁹ J. Bonnaud,¹⁰ B. Borzykowski,¹¹ L. Boule, A. Blin and E. Testu,¹² M. Fortier,¹³ M. Grieshaber,¹⁴ David,¹⁵ J. Campbell and T. Thompson,¹⁶ D. Carvalho,¹⁷ Itala Film Barriera di Casale,¹⁸ H. Chapman and W. Stone,¹⁹ J. Clark,²⁰ W. Daniels,²¹ H. Danzer,²² J. Desire,²³ F. De Mare,²⁴ H. Dixon,²⁵ E. and C. Dupuis,²⁶ L. Dufay,²⁷ G. Eastman,²⁸

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vorm. Meister, Lucius and Brüning,¹ F. Miller and Millergraph Co.,² E. Perry, Jr.,³ J. Cutting,⁴ C. Pettitt,⁵ E. Buchner,⁶ C. Schleussner,⁷ Denk,⁸ P. Moessard,⁹ J. Plener,¹⁰ Horn,¹¹ A. Humphrey,¹² O. Raethel,¹³ J. Reynolds,¹⁴ M. Risler,¹⁵ F. Rowell,¹⁶ Sandell Films and Plates Ltd. and W. Smalley,¹⁷ G. Schnitzler,¹⁸ E. Schoenfelder and E. Kehle,¹⁹ C. Sciemengo,²⁰ Soc. Balland et Cie,²¹ La Societe H. Merville & Cie,²² Soc. Civile des Pellicules Nouvelles,²³ N. Scott,²⁴ Y. Schwartz,²⁵ Self-Developing Plate Co.,²⁶ G. Selle,²⁷ G. Sershall,²⁸ J. Smith and W. Merckens,²⁹ C. Späth,³⁰ E. Spitzer,³¹ J. Swan and J. Leslie,³² J. Thornton,³³ Vereinigte-Kunstseidefabriken A. G.,³⁴ Vosmar,³⁵ A. Waggett,³⁶ R. Wall,³⁷ J. Warburg,³⁸

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4. Poly. Centr. 1853, **19**, 942.
5. E. P. 8956, 1893.
6. Photo Centr. 1898, **1**, 121.
7. Photo Corres. 1894, **31**, 6, 35.
8. Photo Corres. 1890, **27**, 37; 1891, **28**, 221.
9. E. P. 9461, 1884.
10. E. P. 4896, 1881.
11. Poly. Centr. 1853, **19**, 177.
12. E. P. 1559, 1881.
13. E. P. 19683, 1899.
14. E. P. 1112, 1880.
15. E. P. 2954, 1863.
16. U. S. P. 415566, 1889.
17. E. P. 25243, 1902; abst. J. S. C. I. 1903, **22**, 1148.
18. E. P. 7867, 1897.
19. E. P. 15852, 1896.
20. U. S. P. 1036730, 1912, abst. C. A. 1912, **6**, 3329. See also D. Scotellari, E. P. 3753, 1880.
21. F. P. 457925, 1913.
22. E. P. 28793, 1902.
23. F. P. 393224, 1907; abst. J. S. C. I. 1909, **28**, 109.
24. E. P. 121054, 1918, abst. J. S. C. I. 1919, **38**, 56A.
25. U. S. P. 962788, 1910. See also F. P. 378305, 1907, abst. J. S. C. I. 1907, **26**, 1109.
26. E. P. 21880, 1907.
27. E. P. 12515, 1899, 8498, 1903.
28. E. P. 29261, 1896. See also G. Sershall and J. Kirk, E. P. 17122, 1897. See also U. S. P. 657749, 1900.
29. E. P. 2461, 1907; abst. J. S. C. I. 1907, **26**, 1109.
30. E. P. 23138, 1910; abst. J. S. C. I. 1911, **30**, 109.
31. E. P. 249, 1900.
32. E. P. 9893, 1890.
33. E. P. 4043, 1912.
34. E. P. 21839, 1908, abst. J. S. C. I. 1909, **28**, 200. F. P. 395164,

F. Warlich,¹ J. Wellington,² G. Wood,³ Soc. Anon. des Pellicules Francaises,⁴ Chem. Fabrik Actien vorm. Schering.⁵

Celluloid is inflammable but not explosive,⁶ and many methods have been proposed for reducing this well-marked inflammability. The resinsates of zinc, magnesium, aluminium and tungsten in combination with ethyl acetate, oxalate, formate or butyrate;⁷ colophony, shellac, copal, dammar and turpentine;⁸ nitronaphthalin,⁹ mastic,¹⁰ fatty oil with *p*-nitrotoluene,¹¹ polymerization products of cumarones and indenes;¹² carrageen moss,¹³ are some of the bodies which have been advocated. The materials which have been proposed to decrease the speed of burning of nitrocellulose are discussed in detail elsewhere in this volume.

Finely pulverized "virgin" cellulose combined with pyrox-lylin formed the cellulodine of U. Marga;¹⁴ cellulose aceto-nitrates constituted the essence of the processes of C. Haeussermann,¹⁵

1908; abst. J. S. C. I. 1909, **28**, 329.

35. Zts. Wiss. Mikr. 1900, **17**, 36.

36. E. P. 23221, 1911.

37. E. P. 775, 1882.

38. Dansk. fotogr. Tidsskrift, 1916, Pts. 9-10; Brit. J. Phot. 1917, **64**, 96; C. A. 1917, **12**, 1934.

1. E. P. 376, 1891.

2. E. P. 1573, 1896.

3. E. P. 13191, 1890.

4. Eder. Jahr. Phot. 1899, 511. Soc. anon. Le Camphre; F. P. 452432.

5. E. P. 22725, 1905.

6. See Celluloid Ind. 1901, **16**, 10; abst. J. S. C. I. 1902, **21**, 134. Cf. Chem. Trade J. **62**, 304; abst. Chem. Zentr. 1919, **90**, II, 191; Kunst. 1919, **9**, 109.

7. C. Shrager and R. Lance, F. P. 470726; E. P. 8283, 1913.

8. F. Eckstein, E. P. 11569, 1889; abst. J. S. C. I. 1890, **9**, 838, 954.

9. H. Lagneau, E. Nebel and M. Vignes, F. P. 360912, 1905.

10. H. Koller, D. R. P. 66055; abst. Wag. Jahr. 1893, **29**, 1118. G. Koller, Belg. P. 243162.

11. E. van den Kerkhoff, F. P. 429879; abst. J. S. C. I. 1911, **30**, 1324; D. R. P. 240951, abst. Kunst. 1912, **2**, 34; C. A. 1912, **6**, 2186. See E. P. 15914, 1894.

12. F. Lehman and J. Stocker, D. R. P. 297149, 1917; abst. Chem. Zentr. 1917, **88**, I, 939.

13. H. Heydenhauss, U. S. P. 950392, abst. J. S. C. I. 1910, **29**, 417; E. P. 18694, 1909; abst. J. S. C. I. 1910, **29**, 941; Kunst. 1911, **1**, 57; F. P. 406139; abst. J. S. C. I. 1910, **29**, 417; D. R. P. 220865; abst. C. A. 1910, **4**, 2582; Zts. ang. Chem. 1910, **23**, 959; Chem. Zentr. 1910, **81**, I, 1568; Zts. Chem. Ind. Koll. 1910, **7**, 238. H. Heydenhauss, A. Banhegyi and K. Glaser, Belg. P. 218535, 1909, Aust. P. 42233.

14. E. P. 21470, 1895.

15. Chem. Ztg. 1905, **29**, 667, abst. J. S. C. I. 1905, **24**, 748; Jahr. Chem. 1905-1908, II, 983; Zts. ang. Chem. 1905, **18**, 1899; Chem. Centr. 1905, **76**, II, 760; J. C. S. 1905, **83**, 574; Wag. Jahr. 1905, **51**, 192.

• L. Lederer,¹ E. Berl and W. Smith,² J. Schmerber and L. Morane,³ E. Zühl,⁴ H. Nishida,⁵ and W. Parkin and A. Williams,⁶ while L. Bethisy, L. Fouchard and E. Vignes⁷ depend upon a combination of boric acid and *Unona selanica*.

However, those bodies which have given best results in practice in reducing the inflammability of celluloid while at the same time conserving its desirable properties, are combinations with gelatin, fish glue and casein—especially the latter. The methods of G. Convert,⁸ C. Bernadac,⁹ C. Claessen,¹⁰ Casein Co.,¹¹ H.

1. U. S. P. 1028748, 1912, abst. J. S. C. I. 1912, **31**, 637, Mon. Sci. 1912, **77**, 164. E. P. 19107, 1906, abst. J. S. C. I. 1907, **26**, 220. F. P. 368766, 1906, abst. J. S. C. I. 1907, **26**, 20. F. P. 402072, 1909, abst. Mon. Sci. 1911, **74**, 153. D. R. P. 179947, 1905, abst. C. A. 1906, **1**, 1507. J. S. C. I. 1907, **26**, 889, Zts. ang. Chem. 1907, **20**, 1194, Mon. Sci. 1909, (4), **70**, 68, Jahr. Chem. 1905-1908, II, 433, Chem. Zentr. 1907, **78**, I, 443, Wag. Jahr. 1907, **53**, I, 419. D. R. P. 200149, 1905, being Addition to D. R. P. 179947, abst. Zts. ang. Chem. 1908, **21**, 2017, Wag. Jahr. 1908, **54**, II, 365, Jahr. Chem. 1905-1908, II, 986. D. R. P. 210778, 1906, abst. Chem. Zentr. 1909, **80**, II, 247, Chem. Zts. 1909, **8**, 1474, Zts. ang. Chem. 1909, **22**, 1620, Chem. Ind. 1909, **32**, 383, Jahr. Chem. 1909, **62**, II, 389, Wag. Jahr. 1909, **55**, II, 390. E. P. 19107, 1906, F. P. 368766. D. R. P. 179947, cover the same ground, i. e., the treatment of nitrocellulose either with acetic anhydride or acetyl chloride, perhaps in the presence of carbon tetrachloride. D. R. P. 200149 adds treatment with glacial acetic acid, while U. S. P. 1028748, F. P. 102072, D. R. P. 210778, demitrates the mixed acetate-nitrate to decrease the inflammability.

2. Ber. 1907, **40**, 903, abst. J. S. C. I. 1907, **26**, 273, C. A. 1907, **1**, 2179, J. C. S. 1907, **92**, 289, Chem. Ztg. Rep. 1907, **31**, 257, Jahr. Chem. 1905-1908, II, 982, Zts. ang. Chem. 1908, **21**, 1185. See also E. Berl and W. Smith, J. S. C. I. 1908, **27**, 531, abst. Jahr. Chem. 1905-1908, II, 985, Zts. ang. Chem. 1908, **21**, 2427. H. Ost, Zts. ang. Chem. 1906, **19**, 922. A. Green and A. Perkin, J. C. S. 1906, **89**, 811. Pictet and P. Genquand, Ber. 1902, **35**, 2526. E. Berl and W. Smith, Ber. 1908, **41**, 1837, abst. J. C. S. 1908, **94**, i, 505, Bull. Soc. Chim. 1909, (4), **6**, 199, Zts. ang. Chem. 1908, **21**, 1855, 2427.

3. E. P. 4863, 1903, abst. J. S. C. I. 1904, **23**, 382. F. P. 321121, 1902, abst. J. S. C. I. 1904, **23**, 569.

4. U. S. P. 729990, 1903, abst. J. S. C. I. 1903, **22**, 817. D. R. P. 162239, 1902, abst. Zts. ang. Chem. 1906, **19**, 498, Chem. Centr. 1905, **76**, II, 1000.

5. Kunst. 1914, **4**, 141, abst. J. S. C. I. 1914, **33**, 476, C. A. 1914, **8**, 2250. See also D. Florentin, F. P. 415798, 1912, abst. Kunst. 1913, **3**, 274, Mon. Sci. 1913, **78**, 143.

6. E. P. 26657, 1909, abst. J. S. C. I. 1910, **29**, 1152.

7. U. S. P. 625313, 1899, 894108, 1908, F. P. 275161, 368004, 1906, abst. J. S. C. I. 1906, **25**, 1231, Mon. Sci. 1908, (4), **68**, 142, Proc. Amer. Pharm. Assoc. 1899, **47**, 706, Pharm. Journ. Jan. 28, 1899, 75, Brit. J. Phot. 1893, **46**, 4; E. P. 11927, 1898.

8. F. P. 335694, 1903. Product called "Lactite, Vornalithe."

9. Aust. P. 13832, 1903. See also E. P. 21485, 1892, U. S. P. 700471; abst. J. S. C. I. 1902, **21**, 986.

10. D. R. P. 163668; abst. Jahr. Chem. 1905-1908, II, 992.

11. E. P. 23752, 1903, abst. J. S. C. I. 1904, **23**, 266, F. P. 336405; abst. Mon. Sci. 1905, (4), **62**, 23.

Cathelineau and A. Fleury,¹ H. Ensminger,² H. Franquet,³ E. Delahaye⁴ and Rouland⁵ all combine nitrocellulose with casein. Cie Francaise du Celluloid, add also urea.⁶ Pyroxylin and fish glue form the novelty in the processes of W. Woodward,⁷ Commercial Products Co.,⁸ and the "Mestrine" of E. Mestrallet-Petry.⁹ Vegetable oils,¹⁰ as castor,¹¹ soya bean,¹² especially when oxidized;¹³ gelatin combined with nitrocellulose in the hands of L. Bondet,¹⁴ P. and S. Borrot,¹⁵ I. Traube,¹⁶ G. Woodward,¹⁷ V. Vender,¹⁸ J. Stocker and V. Lehman,¹⁹ Societe Anonyme L'oyon-

1. D. R. P. Addn. 185241 to D. R. P. 185240; abst. Mon. Sci. 1910, (4), **72**, 76; Chem. Zentr. 1907, **78**, II, 1819; Chem. Ztg. Rep. 1907, **31**, 396; Wag. Jahr. 1907, 563. D. R. P. 185246; abst. Zts. ang. Chem. 1907, **20**, 2177; Chem. Zentr. 1907, **78**, II, 1037, 1819; Chem. Ztg. Rep. 1907, **31**, 361; C. A. 1908, **2**, 349; Wag. Jahr. 1907, **53**, II, 563; add. 4898 to F. P. 354942. See also A. Chanard, D. R. P. 221080, 1908. P. Castle, E. P. 19130, 1895. G. Caul, Belg. P. 149782, 1900.
2. F. P. 318385; abst. J. S. C. I. 1902, **21**, 1462. F. P. 326576; abst. J. S. C. I. 1903, **22**, 817. E. P. 3045, 1903; abst. J. S. C. I. 1903, **22**, 254.
3. E. P. 14981, 1901; abst. J. S. C. I. 1902, **21**, 925. F. P. 312846; abst. J. S. C. I. 1902, **21**, 134, 925, 986. F. P. 313846; abst. Mon. Sci. 1903, (4), **59**, 12. F. P. 317607; abst. J. S. C. I. 1902, **21**, 1408, Mon. Sci. 1903, (4), **59**, 120. D. R. P. 138783; abst. Chem. Centr. 1903, **74**, I, 485; Wag. Jahr. 1903, **49**, II, 570, Jahr. Chem. 1903, **56**, 1019. Add. 139905 to D. R. P. 138783; abst. Mon. Sci. 1904, (4), **60**, 92; Chem. Centr. 1903, **74**, II, 800. Includes the caseinates of iron, potassium, sodium, ammonium, aluminum, zinc, magnesium, copper and nickel.
4. Swiss P. 57059; abst. Kunst. 1913, **3**, 28.
5. Rev. ind. **37**, 350.
6. F. P. 324894, abst. J. S. C. I. 1903, **22**, 646. F. P. 328658; abst. J. S. C. I. 1903, **22**, 1012.
7. U. S. P. 803952, 1905; E. P. 9277, 1904; F. P. 344048, 1904; D. R. P. 171428, 1904; Aust. P. 23151; abst. J. S. C. I. 1904, **23**, 1111; 1905, **24**, 149, 1251; Sci. Am., Feb. 17, 1906; Wag. Jahr. 1906, **52**, II, 526; Mon. Sci. 1908, **68**, 45. Can. P. 95015. Belg. P. 177495. Dan. P. 7316, 1905.
8. Can. P. 120214, 1900.
9. F. P. 372018; abst. J. S. C. I. 1907, **26**, 430; Mon. Sci. 1908, (4), **68**, 143. See W. Massot, Zts. ang. Chem. 1908, **21**, 340.
10. Dusseldorfer Celluloid Fabrik, Belg. P. 237160, 1911.
11. L. Fiorillo, Swiss P. 44228.
12. S. Satow, U. S. P. 1245976; abst. C. A. 1918, **12**, 412, U. S. P. 1245975; abst. J. S. C. I. 1918, **37**, 27-A; U. S. P. 1245976; abst. C. A. 1918, **12**, 412. U. S. P. 1245983; abst. C. A. 1918, **12**, 412; U. S. P. 1245984; abst. C. A. 1918, **12**, 208. Jap. P. 28307, 29247; abst. C. A. 1918, **12**, 224.
13. B. Goldsmith, U. S. P. 1152625; abst. Mon. Sci. 1916, **83**, 78. See also F. Botrelle and G. Fretard, Belg. P. 242735, 1912.
14. F. P. 372599; abst. J. S. C. I. 1907, **26**, 634. D. R. P. 191796; abst. Wag. Jahr. 1908, II, 540.
15. Belg. P. 189469, 1906.
16. D. R. P. 173592, 1906; abst. Wag. Jahr. 1906, **52**, I, 365.
17. Aust. P. 23151, 1905. D. R. P. 110012. See F. P. 319926.
18. Ital. P. 107206, 1909.
19. D. R. P. 45024; abst. Bay. Ind. Gewerb. 1889, **21**, 94; 202133; abst. J. S. C. I. 1908, **27**, 1174; Zts. ang. Chem. 1908, **21**, 2334; Chem. Zentr.

naxienne,¹ F. Kohl,² M. Jolles and L. Lilienfeld,³ H. Jerne,⁴ Hock,⁵ C. Tissier and P. Magnier⁶ and G. de Briailles,⁷ have been described.

Other attempts to conserve plasticity while reducing inflammability in nitrocellulose compounds are the endeavors of R. Ortmann,⁸ C. Hellriegel,⁹ Bruhat,¹⁰ A. Dinin,¹¹ J. Aylesworth,¹² E. Peyrussen,¹³ H. Blutcher and E. Krause,¹⁴ T. Stagg,¹⁵ J. Smith,¹⁶ Societe Industrielle de Cellulose,¹⁷ W. Brigham,¹⁸ A. Rowe,¹⁹ and the "nitro-epidermose" of L. Nottelle.²⁰

The recovery of celluloid, utilization of celluloid waste,²¹

1908, **79**, II, 1312, Chem Tech Rep 1908, **32**, 526, C. A. 1909, **3**, 494, Addn 222319 to D. R. P. 202133, abst. Chem Zentr 1910, **81**, II, 52, Chem Ind. 1910, **33**, 412; Zts Chem Ind Koll 1910, **7**, 318 Aust P 41517 D. R. P. Ann L-36336, abst. Kunst 1914, **4**, 220

1. F. P. 320133, abst. J. S. C. I. 1903, **22**, 104, F. P. 331819, abst. J. S. C. I. 1903, **22**, 1206, F. P. 472192

2. D. R. P. 114278, abst. Mon. Sci. 1901, **57**, 102, Chem Centr 1900, **71**, II, 1002, Wag. Jahr. 1900, **46**, II, 566, Jahr Chem 1900, **53**, 850, Bull Soc Franc Phot 1901, II, **17**, 372

3. E. P. 30161, 1896, abst. J. S. C. I. 1897, **16**, 84, 850, 1898, **17**, 69.

4. U. S. P. 1043600, abst. C. A. 1913, **7**, 187.

5. F. P. 74881, 1887

6. F. P. 320931, abst. J. S. C. I. 1903, **22**, 160, Mon. Sci. 1903, **59**, 124. See also E. P. 15355, 1890

7. F. P. 386845, abst. J. S. C. I. 1908, **27**, 834, F. P. 421423, abst. Kunst 1911, **1**, 156, 1914, **4**, 286, F. P. 420044, abst. Kunst 1911, **1**, 156. E. P. 8542, 1908; abst. J. S. C. I. 1908, **27**, 877

8. E. P. 5280, 1904, F. P. 343464, 1904, abst. J. S. C. I. 1904, **23**, 948.

9. E. P. 22186, 1899; abst. J. S. C. I. 1901, **20**, 62

10. E. P. Appl 17797, 1919, abst. J. S. C. I. 1919, **38**, 560-A.

11. F. P. 485135, 1917, abst. C. A. 1919, **13**, 1928

12. U. S. P. 962769, 962770, 962788; abst. Mon. Sci. 1911, **74**, 11.

13. F. P. 374395, 1906, abst. Mon. Sci. 1908, (4), **68**, 144. See C. Gillet, F. P. 382270, 1906, abst. Mon. Sci. 1909, (4), **70**, 13, F. P. 382350

14. D. R. P. 275857; abst. Kunst 1914, **4**, 273, C. A. 1915, **9**, 361 Swiss P. 74339, abst. C. A. 1917, **11**, 2030, Swiss P. 76279, abst. C. A. 1918, **12**, 1112, E. P. 76, 1914, 11563, 1915; abst. C. A. 1917, **11**, 194.

15. E. P. 2188, 1910. See also G. Galy, F. P. 400285, 1909.

16. E. P. 10372, 1905, abst. J. S. C. I. 1905, **24**, 1083, E. P. 1454, 1906

17. F. P. 319926, abst. J. S. C. I. 1902, **21**, 1550

18. U. S. P. 233973, 1880. See also Follen u. Flitterfabr. A.-G., E. P. Appl 16458, 1920, abst. J. S. C. I. 1920, **39**, 504-A

19. E. P. 21708, 1912, abst. J. S. C. I. 1913, **32**, 1027.

20. E. P. 23619, 1904; abst. J. S. C. I. 1905, **24**, 1076.

21. Anthony's Photo Bull 1891, **22**, 700. Amat Phot 1898, **28**, 902; 1900, **31**, 449, 1905, **42**, 97. Materialenkunde den Kautschuk Techniker 1906, **3**, 138, 248. Gummi-Ztg. 1910, **8**; Bayer Ind. und Gewerbe. 1911, **43**, 107. Zts. Abfallverwertung, 1917, 56. For the recovery of camphor, etc., from celluloid see E. Garbin and C. Gerard, F. P. 354839, 1905; Ital. P. Dec. 1, 1904; abst. Mon. Sci. 1907, **67**, 33. E. Rinmann, Ital. P. 123606; abst. Chem. Ztg. 1913, **37**, 316. H. Ensminger, E. P. 3045, 1903; abst. J. S. C. I. 1904, **23**, 202; F. P. 326576, 1902; abst. J. S. C. I. 1903, **22**, 817. E. Josephson, U. S. P. 1211588; abst. C. A. 1917, **11**, 705.

the rehabilitation of soiled films and the rejuvenation of old ones is an industry of growing importance, and is a subject which has engaged the attention of men of reflection in this art for years. The methods which have been put forth from time to time are summarized in the statements of O. Monroe,¹ I. Kitsee,² H. Cave-Browne,³ E. Garbin,⁴ M. Toryelli,⁵ W. Alexander,⁶ C. Arnold,⁷ J. Bell and H. Vollin,⁸ Deutsche Xylolithfabrik Otto Sening u. C.,⁹ J. George,¹⁰ G. and A. Grove,¹¹ G. Hirst,¹² A. Jaeckel,¹³ E. Josephson,¹⁴ O. Monroe,¹⁵ R. Muller,¹⁶ C. Parkert,¹⁷ H. Tas and J. David.¹⁸

The physical constants and chemical properties of the pyroxilin plastics have been the subject of a number of serious investigations more recently from the viewpoint of colloid-chemical phenomena yet at the present time we have but an imperfect knowledge of the inner mechanics of the plasticizing process.¹⁹ For a survey of this subject, the reader is referred to

1. U. S. P. 244916, 1881.
2. U. S. P. 701357, 1902, 767646, 1904, abst. J. S. C. I. 1904, **23**, 880.
3. E. P. 22299, 1903, abst. J. S. C. I. 1904, **23**, 909.
4. U. S. P. 874481, 1907, abst. J. S. C. I. 1908, **27**, 88. E. Garbin, C. and G. Gerard, E. P. 10319, 1905, abst. J. S. C. I. 1905, **24**, 1028, F. P. 354389, 1905, abst. J. S. C. I. 1905, **24**, 1081, C. A. 1907, **1**, 1498. D. R. P. 188344, 1907, 185190, 1905, abst. Chem. Zentr. 1907, **78**, II, 1037, Chem. Ztg. Rep. 1907, **31**, 536. Gerard, Garbin and Picardo, Belg. P. 189389, 1906. G. and E. Gerard, Aust. P. 31379, 1907.
5. E. P. 9568, 1907, abst. J. S. C. I. 1908, **27**, 589, F. P. 373273, 1907, abst. J. S. C. I. 1907, **26**, 776, Mon. Ser. 1908, **68**, 143, D. R. P. 205865, abst. Wag. Jahr. 1909, **55**, II, 554, C. A. 1909, **3**, 1937, Zts. ang. Chem. 1909, **22**, 505, Chem. Zentr. 1909, **80**, I, 1063, Chem. Ztg. Rep. 1909, **33**, 66, Chem. Ind. 1909, **32**, 73, Zts. Chem. Ind. Koll. 1909, **4**, 207. Belg. P. 197000, 1907.
6. Photography, 1904, **19**, 570.
7. U. S. P. 1195431, 1916, abst. C. A. 1916, **11**, 2637.
8. E. P. 468376, abst. Kunst. 1914, **4**, 370.
9. C. and G. Gerard and E. Garbin, D. R. P. 185190, 189971, abst. C. A. 1908, **2**, 349, Chem. Zentr. 1907, **78**, II, 1037, Jahr. Chem. 1905-08, II, 994, Chem. Ztg. Rep. 1907, **31**, 303, 619.
10. E. P. 11243, 1906.
11. E. P. 13046, 1904.
12. E. P. 503, 1884.
13. Die Celluloid Ind. 1911, **33**, abst. Bayer Ind. Gewerbl. 1912, **44**, 247; Celluloid Ind. 1913, **8**, 62; abst. Kunst. 1913, **3**, 154, cf. Kunst. 1912, **2**, 56.
14. U. S. P. 1211588, 1917, abst. J. S. C. I. 1917, **36**, 288.
15. U. S. P. 244916, 1881; abst. Chem. Ind. 1881, **4**, 434.
16. D. R. P. Ann. M.-51952, 1913, abst. Kunst. 1914, **4**, 384. D. R. P. 280873, 1915; abst. Chem. Zentr. 1915, **86**, II, 864; C. A. 1916, **10**, 2146.
17. Kunst. 1918, **8**, 61; abst. C. A. 1919, **13**, 1926.
18. E. P. 22528, 1907.
19. Wilson's Photo-Mosaics, 1891, 37.

the memoirs of G. Addenbrooke,¹ H. Schwarz,² A. Dubosc,^{3,4} Underwriters Bureau,⁵ National Fire Protective Association,⁶ A. Voigt,⁷ W. Will,⁸ H. Nishida,⁹ J. Brown,¹⁰ H. Flemming,¹¹ H. Stokes and H. Weber,¹² P. Weimarn,¹³ J. and I. Hyatt,¹⁴ A. Panzer,¹⁵ J. Bronn,¹⁶ V. Lefebure,¹⁷ B. Pfyl and F. Rasenack,¹⁸ Spence,¹⁹ H. Schwarz,²⁰ J. Goldsmith,²¹ Excelsiorwerk Fabr. für Feinmechanik,²² A. Woscher,²³ G. Addenbrooke,²⁴ V. Lefebure,²⁵ H. Ambronn,²⁶ F. Boeckmann,²⁷ G. Bonwitt,²⁸ P. Breteau and H. Leroux,²⁹

- 1 The Electrician, 1911, **66**, 629
- 2 Kolloid Chem. Beihefte, 1914, **6**, 90, abst. C. A. 1915, **5**, 524, 3128; J. C. S. 1914, **106**, i, 1053; J. S. C. I. 1914, **33**, 856; Mon. Sci. 1915, **82**, 49; Chem. Zentr. 1914, **85**, II, 853; Kunst. 1913, **3**, 135, 1914, **4**, 306
- 3 Caout. et Gutta-p. 1914, **16**, 893, abst. J. S. C. I. 1919, **38**, 531-A; C. A. 1920, **14**, 626
- 4 Report of the Dept. Committee on Celluloid (Cd. 7158), abst. J. S. C. I. 1913, **32**, 1152
- 5 Nat. Fire Prot. Assoc. Quart. Oct. 1913, abst. C. A. 1914, **8**, 572
- 6 Quarterly, **7**, 444, abst. C. A. 1914, **8**, 2481. See also India Rubber World, 1912, **47**, 45
- 7 Zts. ang. Chem. 1906, **19**, 286, abst. Chem. Centr. 1906, **77**, I, 297, 981
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For most technical purposes, the analysis of pyroxylin plastics is limited to a determination of nitrogen, nitrocellulose, camphor, camphor substitutes (where possible), stabilizers and certain mechanical tests. Nitrogen is determined by the nitrometer as has been detailed on page 964 of this volume. Camphor may be estimated by the methods of F. Förster,²⁰ Utz,²¹ A. Arnost,²² 1914, **4**, 179.

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22. Z. Nahr. Genuss. 1906, **12**, 532; abst. J. S. C. I. 1906,

and H. Zaunschirm.¹ General analytical schemes have been devised by L. Clement and C. Riviere,² M. Keghel,³ A. Herve,⁴ H. Dubovitz⁵ and E. Barthelemy.⁶ The elasticity, hardness, and temperature of ignitions are also determined. For tensile strength, compression and flexure, the dynamometer is used.

Many materials and combinations have been proposed from time to time as substitutes for celluloid, either with the idea in mind of decreasing the inflammability or cost of production, or of imparting some desirable property not present in the celluloid itself. In the main these substitutes have not fulfilled the promises of their promoters. Their properties and preparation form a separate topic in cellulose ester industry, and are to be found treated in detail in Volume V of this series.

Perhaps the foremost of these substitutes are the proteids and albuminoids, gelatin and casein, especially the latter. A certain amount of thermoplasticity may be induced in casein by appropriate treatment, and this combined with a well-marked non-inflammability and stability at extremes of normal atmospheric temperature, have caused the casein plastics to be extensively used in some industries in direct competition with the pyroxylin plastics.

Those interested in following out this line of casein usefulness in plastic formation, are referred to the processes of B. Goldsmith,⁷ R. Adler,⁸ Akt.-Ges. fur Chem. Ind.,⁹ P. Townsend

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and F. Maywald,¹ A. Bartels,² H. Barthelemy,³ C. Baumann and G. Diesser,⁴ F. Beltzer,⁵ F. Berberich and W. Schröder,⁶ L. Barnett,⁷ A. Bernstein,⁸ G. Betz,⁹ K. Boerma,¹⁰ G. Bonwitt,¹¹ W. Callender,¹² J. Bousfield,¹³ A. Chanard,¹⁴ A. Chaplet,¹⁵ Chemische Fabrik vorm. Schering,¹⁶ E. Childs,¹⁷ Cie Francaise de la Galalith,¹⁸ J. Davidson and J. Nightingale, A. Hood,¹⁹ R. Desgeorge,²⁰ R. Desouches, A. Riasse and A. Duron,²¹ Deutsche Kunsthorn Ges.,²² F. Dobler,²³ H. Dunham,²⁴ A. Duprat,²⁵ O. Eberhard and O. Mierisch,²⁶ L. Erasmus,²⁷ R. Fairback,²⁸ G. Frye,²⁹ G. Gluecktner,³⁰

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 10. E. P. 1016, 1914; abst. J. S. C. I. 1915, **34**, 564.
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 17. F. P. 420164; abst. Kunst. 1911, **1**, 156, 174, 1913, **3**, 412; J. S. C. I. 1911, **30**, 276.
 18. D. R. P. 281541, 1915; abst. Chem. Zentr. 1915, **86**, I, 282; C. A. 1915, **9**, 2163; J. S. C. I. 1915, **34**, 488; D. R. Anm. St.-19139; abst. Kunst. 1914, **4**, 370.
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23. Aust. P. 52507; abst. Kunst. 1912, **2**, 213. Aust. P. Anm. 8885/10.
24. U. S. P. 670689, 1897. D. R. P. 107637. Aust. P. 2774. F. P.

berg,¹ V. Seitz,² Soc. anon. La Cornalithe,³ Societe Le Clerc et Mabille,⁴ Soc. Mariller et Robelet,⁵ A. Spitteler,⁶ J. Steffens,⁷ H. Stein,⁸ H. Stephan,⁹ E. Stich,¹⁰ J. Stockhausen,¹¹ R. Tambach,¹² F. Thomas,¹³ H. Timpe and J. Jurgens,¹⁴ Ver. Gummi-Waaren Fabriken Harburg-Wien vorm. H. Menier and N. Reithoffer,¹⁵ P. Voigt,¹⁶ E. Weckwarth and M. Hoeft,¹⁷ R. Weiss,¹⁸ C. Weygang,¹⁹ K. Wernicke,²⁰ W. Wolff & Co.,²¹ L. Wolter,²² C. Wittkowsky,²³

470580, 1913

²⁵ E. P. 13601, 1909, abst. Kunst 1912, **2**, 235, J. S. C. I. 1910, **29**, 98. See also E. P. 14240, 1894, 17953, 1907

¹ D. R. P. 225259; abst. Wag. Jahr 1910, **56**, II, 588, Zts. ang. Chem. 1910, **23**, 2351; Chem. Zentr. 1910, **81**, II, 1262. D. R. P. 229906, abst. Wag. Jahr. 1911, **57**, II, 551. Aust. P. 47674; abst. Kunst. F. P. 358172, 1905; abst. J. S. C. I. 1906, **25**, 190. H. Schwarzberg and E. Noa, U. S. P. 864388, 1907.

² Aust. P. 56952, abst. Kunst 1913, **3**, 75

³ F. P. 337695; abst. J. S. C. I. 1904, **23**, 553

⁴ F. P. 361610, 1906

⁵ Addn. of Aug. 17, 1900 to F. P. 292939.

⁶ D. R. P. 115681; abst. Wag. Jahr. 1900, **46**, II, 567. E. P. 17258, 1902, abst. J. S. C. I. 1903, **22**, 815. Aust. P. 3617, 1900

⁷ U. S. P. 169053.

⁸ D. R. Ann. St. 16842, Kunst 1912, **2**, 379. D. R. P. 254992, 1911; abst. J. S. C. I. 1913, **32**, 420, Kunst 1913, **3**, 50, C. A. 1913, **7**, 1288.

⁹ D. R. Ann. St. 15560, St. 17683, D. R. P. 240249, abst. Wag. Jahr. 1911, **57**, II, 551, C. A. 1912, **6**, 2122; Zts. ang. Chem. 1911, **24**, 2288. D. R. P. 264567; abst. Kunst. 1913, **3**, 396

¹⁰ Kunst 1915, **5**, 145, 158, 171, 185. See J. Tahan, U. S. P. 852915, 1907

¹¹ U. S. P. 1061881, 1913, abst. J. S. C. I. 1913, **32**, 616, Kunst 1914, **4**, 268. E. P. 9264, 1911, abst. J. S. C. I. 1912, **31**, 195; Kunst. 1912, **2**, 215. E. P. 27663, 1913, abst. Kunst 1914, **4**, 360, J. S. C. I. 1914, **33**, 653.

D. R. P. 280144, abst. C. A. 1915, **9**, 1408; Kunst 1914, **4**, 370. D. R. P. 280216, abst. C. A. 1915, **9**, 2163, Kunst 1914, **4**, 380, 384. D. R. P. 281268; abst. C. A. 1915, **9**, 2163, Kunst 1914, **4**, 396. F. P. 466435, abst. J. S. C. I. 1914, **33**, 605. F. P. 465306, 1913, abst. J. S. C. I. 1914, **33**, 558. F. P. 428468; abst. Kunst 1914, **4**, 268, J. S. C. I. 1911, **30**, 1271. Aust. P. 57422, 57428; abst. Kunst. 1913, **3**, 218. Hung. P. Appl. S. 5679. Swiss P. 56153, 1911. Can. P. 138334, 1911.

¹² U. S. P. 1037685, 1910, abst. C. A. 1912, **6**, 3481.

¹³ D. R. P. 163818, abst. Chem. Centr. 1905, **76**, II, 1652

¹⁴ E. P. 25400, 1910, F. P. 356508, abst. J. S. C. I. 1911, **30**, 847; C. A. 1907, **1**, 1064, 1079.

¹⁵ D. R. P. 134314; abst. Wag. Jahr. 1902, **48**, II, 593. D. R. P. 141309; abst. Wag. Jahr. 1903, **49**, II, 571. D. R. P. 147994; abst. Wag. Jahr. 1904, **50**, II, 513. See also Bayer Ind. 1904, 393.

¹⁶ D. R. P. 200139, 1906; abst. Mon. Sci. 1911, **75**, 93, Wag. Jahr. 1908, **54**, II, 542. Dan. P. 10952, 1907

¹⁷ E. P. 21735, 1894; abst. J. S. C. I. 1895, **14**, 577.

¹⁸ E. P. 107769, 1917; abst. J. S. C. I. 1917, **36**, 1280. E. P. 115439, 1918. D. R. P. 313881, 1917; E. P. 115439, 1918, abst. J. S. C. I. 1920, **39**, 36-A, 343-A.

¹⁹ E. P. 111171; abst. J. S. C. I. 1918, **37**, 14-A.

²⁰ Kunst. 1912, **2**, 181, 205; abst. C. A. 1912, **6**, 2295.

F. Wiechmann,¹ and others² are representative of advancement.

Gelatin which has undergone indurating treatment as with formaldehyde, bichromate, tannin and aromatic hydroxyl derivatives (naphthols), may be rendered supple and tenuous by the addition of glycerol, sulfonated or other oils. With gelatin and glue combinations, however, the thermoplasticity is usually very low, which is their prime drawback to successful competition with pyroxylin compounds. Some of the processes which have been put forward, are described by F. Zu Aichburg,³ A. Bardin,⁴ C. Bedford and F. Atkins,⁵ E. Benedictus,⁶ P. Brosse,⁷ H. Busch,⁸ W. Clark,⁹ A. Eaton,¹⁰ M. Pozzi-Escot,¹¹ K. Hagendorf and A. Breslauer,¹² W. van der Heyden and J. Jurgens,¹³ J. Hyatt,¹⁴ P. Jacquemin and R. Heraud,¹⁵ H. Libs,¹⁶ A. MacFarlane and H. Stanbury,¹⁷ M. Marsan,¹⁸ H. Pflüger,¹⁹ R. Pioget,²⁰ W. Plinatus,²¹

21. D. R. P. 275160, 1912, abst. C. A. 1914, **8**, 3375.
22. Chem. Ztg. 1909, **33**, 11, abst. Wag. Jahr. 1909, **55**, II, 561; J. S. C. I. 1909, **28**, 101.
23. E. P. 23632, 1909, abst. J. S. C. I. 1910, **29**, 1383.
1. E. P. 6573, 1908, abst. C. A. 1909, **3**, 1326.
2. In this connection see also the plastic compositions proposed by A. Chanard, F. P. 445843, 1912. Chem. Werke vorm. Dr. H. Byk, D. R. P. 252193, 1910. A. Baer, F. P. 443923, 1912. Portolac Holzmasse Ges., F. P. 444184, 1912. G. Diesser, E. P. 16616, 1912, abst. C. A. 1914, **8**, 217; F. P. 446348, 1912, abst. J. S. C. I. 1913, **32**, 151, 835. Celluloid Co., D. R. P. 251372, 1910. A. and M. Weiser, Swiss. P. 77143; abst. Kunst. 1919, **9**, 95. E. Krause and H. Blucher, Can. P. 201420, 1920. W. Plinatus, Aust. P. 74596, 1919, abst. Kunst. 1919, **9**, 124. J. Geistdorfer, Belg. P. 241914, 1912. L. Collardon, F. P. 350376, 1904, E. P. 27090, 1904; abst. J. S. C. I. 1905, **24**, 842; 1906, **25**, 179.
3. E. P. 4904, 1910, abst. J. S. C. I. 1911, **30**, 99; F. P. 415542, 1910; abst. J. S. C. I. 1910, **29**, 1321.
4. E. P. 9666, 1913, abst. Kunst. 1914, **4**, 76. F. P. 415542, 1910.
5. E. P. 8201, 1909, abst. J. S. C. I. 1910, **29**, 405.
6. E. P. 10293, 10324, 1911; F. P. 405881, 1910; Addn. 14829, 439644, 1911.
7. E. P. 24110, 1908, J. S. C. I. 1909, **28**, 579.
8. U. S. P. 1105060, abst. C. A. 1914, **8**, 3154.
9. E. P. 441, 1883, 4487, 1893; abst. J. S. C. I. 1883, **2**, 92; 1893, **12**, 307, 1894, **13**, 91, 168, 169.
10. U. S. P. 129217, 1872.
11. F. P. 362010, 1905. See also G. Dissier, Belg. P. 244823, 1912.
12. D. R. P. 288347, Addn. to 274179; abst. C. A. 1916, **10**, 2285.
13. E. P. 9579, 1910; abst. J. S. C. I. 1910, **29**, 1467.
14. U. S. P. 317390.
15. F. P. 424820, 433148, 1910; abst. C. A. 1912, **6**, 1972.
16. F. P. 385459, 1907; abst. C. A. 1909, **3**, 1819.
17. E. P. 3678, 1898; abst. J. S. C. I. 1898, **17**, 298, 1212; 1899, **18**, 154.
18. F. P. 452324, 1912. See also L. Gauthier, E. P. 128905; abst. J. S. C. I. 1920, **33**, 450-A.
19. D. R. P. 187479, 1905; abst. Chem. Zentr. 1907, **78**, II, 1820.
20. U. S. P. 1263284, 1918; E. P. 106448, 1917; abst. J. S. C. I. 1917,

M. de la Ramee,¹ Soc. des Colles et Gelatines Francaises,² Soc. Francaise du Ceramoid,³ Gummi (Foreign), Ltd.,⁴ W. Stadler,⁵ Steinkern Ind. Ges.,⁶ A. Szolayski,⁷ Verein. Gelatin-Gelatoidfolien- und Flitterfabriken,⁸ W. Weidenmüller and Beer,⁹ A. Chanard.¹⁰ Ossein forms the basis of the plastics of J. Hunter,¹¹ and A. Helbronner and E. Valee.¹²

Other similar plastic combinations are to be found in the processes of L. Labbe,¹³ Soc. Anon. l'Oxygnaxienne,¹⁴ R. Alexander,¹⁵ Naam. Venn. Algemeene Uitvinding Exploatie Maatschappij,¹⁶ J. Ancira,¹⁷ W. Appleyard,¹⁸ S. Barbier and C. Coiffier,¹⁹ J. Basenau and Cohen,²⁰ G. Bestwick,²¹ M. Boyon,²² British Xylonite Co. and J. Goldsmith,²³ Broadhurst,^{*} Lamble, Peachey and United Alkali

36, 728, 1918, **37**, 344-A

²¹ E. P. 4080, 9609, 9616, 1910, 25449, 1911, 12142, 1913, F. P. 450967, 1912, 465048, 474570, 1913, Belg. P. 251275

¹ E. P. 1587, 1901, 28508, 1911, Belg. P. 231270, 1910, F. P. 437751, 1911

² E. P. 29509, 1910, abst. Chem. Ztg. Rep. 1912, **36**, 273

³ E. P. 112196, 1917, abst. J. S. C. I. 1918, **27**, 89 A

⁴ F. P. 454905, 1913, abst. C. A. 1914, **8**, 832

⁵ D. R. P. 220493, 1909. See also H. Timpe and J. Jurgens, F. P. 25400, 1910

⁶ Belg. P. 203628, 1907. See also S. Satow, Can. P. 191261, 191428, 1920

⁷ E. P. 1223, 1914, F. P. 463906, 1913, Swiss P. 64941, 1913, abst. J. S. C. I. 1914, **33**, 417, Belg. P. 261486, 1913

⁸ D. R. P. 122068, 123311, abst. Wag. Jahr. 1901, **47**, 11, 609

⁹ Aust. P. 43386, 1919

¹⁰ E. P. 28598, 1909. See D. R. P. 111310, 1902, F. P. 319542, 1902.

¹¹ D. R. P. 179833, 1905; abst. Chem. Zentr. 1907, **78**, 11, 1473, E. P. 2455, 1905, U. S. P. 781880, 781881, 781882, 781883, 781884, 1905

¹² E. P. 20548, 1906, F. P. 361796, D. R. P. 197250, 202265, Swiss P. 41005, Aust. P. 40163, India P. 537, 1906

¹³ U. S. P. 1112297, E. P. 12746, 1911, 21458, 1912, F. P. 410793, 430035; Addn. 14809, D. R. P. 251259, 262092, Aust. P. 57706, 63180, Belg. P. 249348

¹⁴ U. S. P. 444775; D. R. P. 220865, 1908, Aust. P. 29281, 29831, 29832, 1905

¹⁵ U. S. P. 351611; abst. Kunst. 1913, **3**, 450.

¹⁶ U. S. P. 993626, E. P. 8523, 1912, D. R. P. 236260, 236913, Swiss P. 52280

¹⁷ U. S. P. 688813; abst. Kunst. 1913, **3**, 451.

¹⁸ E. P. 374114, 1907. Called "Psychiloid."

¹⁹ U. S. P. 304772, 1884.

²⁰ U. S. P. 733797. For the use of carrageen moss see H. Heydenhauss, A. Banhegyi and K. Glaser, E. P. 18604, 1909, F. P. 406139, 1909, abst. J. S. C. I. 1910, **29**, 417.

²¹ U. S. P. 648339; E. P. 17277, 1899; abst. Kunst. 1913, **3**, 451.

²² F. P. 443279, 1911. See also W. Bitti, Russ. P. 55373, 1912; ^{*} abst. Chem. Ztg. 1913, **37**, 1942.

²³ E. P. 3147, 1903, abst. J. S. C. I. 1903, **22**, 254.

Co.,¹ E. Cadoret,² U. Chandeysson,³ Chem. Fab. Griesheim-Elektron,⁴ C. Claessen,⁵ P. Contant and J. Perrot,⁶ J. Cox,⁷ J. DeLong,⁸ M. Devey,⁹ R. Dodd and H. Humphries,¹⁰ J. Easton,¹¹ Eborit-Gesellschaft,¹² T. Edison,¹³ Gocher Oelmühle, Gebr. van den Bosch,¹⁴ G. Fretard,¹⁵ J. Gebauer,¹⁶ E. Golonya,¹⁷ C. Granel,¹⁸ E. Granier and E. Froger-Delapierre,¹⁹ L. Grote and A. Vivian,²⁰ B. Harrass,²¹ J. Heany,²² F. Henning and J. Wetter,²³ F. Kaempff,²⁴ O. Kausch,²⁵ T. Kelly,²⁶ F. Kleinsteuber,²⁷ H. Blücher and E. Krause,²⁸ E. and M. Lamort,²⁹ I. Lilienfeld,³⁰ C. Marter,³¹ J. Meyenberg,³²

1. E. P. 127481, 1917; abst. J. S. C. I. 1919, **38**, 446-A.
2. E. P. 12451, 1896. See also K. Scherrer, D. R. P. 265220, 1911.
3. F. P. 430881, 1911. See also Bindley, Weller and Duncan, E. P. 134564, 134565; abst. J. S. C. I. 1919, **38**, 932-A.
4. D. R. P. 219918, 1910; 281687, 281688, 281877; Swiss P. 71809.
5. D. R. P. 216214; abst. Wag. Jahr. 1910, **56**, II, 588; Chem. Zentr. 1909, **80**, II, 2215.
6. F. P. 461007, Addn. 18797, 1913; 467045, 1914, abst. C. A. 1915, **9**, 1391.
7. E. P. 29075, 1910; abst. J. S. C. I. 1911, **30**, 1388; C. A. 1912, **6**, 1506.
8. U. S. P. 622450; abst. Kunst. 1913, **3**, 451. See also N. Magelsen, Dan. P. 17091; abst. Chem. Ztg. 1913, **37**, 358.
9. U. S. P. 490641; abst. Kunst. 1913, **3**, 450. See also Kämmer & Reinhardt, Aust. P. 62370, 1913; abst. Chem. Ztg. 1913, **37**, 1433.
10. U. S. P. 1143893; E. P. 15316, 1913; abst. C. A. 1915, **9**, 132, 2296.
11. U. S. P. 436733; abst. Kunst. 1913, **3**, 450.
12. D. R. P. 191125, 1902; abst. J. S. C. I. 1909, **27**, 820; Chem. Zentr. 1908, **79**, I, 691.
13. U. S. P. 438309; abst. Kunst. 1913, **3**, 390.
14. F. P. 366125, 1906; abst. J. S. C. I. 1906, **25**, 1001.
15. F. P. 452579, 1912. See also Societe Comoy-Vincent, F. P. 432970, 1911.
16. F. P. 415996, 1910. See also G. Koller, J. Herbabny and O. Jolles, D. R. P. 243347, 1911; abst. Chem. Ztg. 1912, **36**, 99.
17. E. P. 15217, 1884.
18. U. S. P. 1190880, 1916; F. P. 453881, 1912; abst. J. S. C. I. 1913, **32**, 876, 983; 1916, **35**, 899.
19. E. P. 6183, 1906; abst. C. A. 1907, **1**, 929.
20. E. P. 18503, 1911; abst. J. S. C. I. 1913, **32**, 36; C. A. 1913, **7**, 426.
21. U. S. P. 254964, 1882.
22. U. S. P. 703198, 703199; E. P. 17745, 17746, 27786, 1902.
23. E. P. 2914, 11905, 1909; abst. J. S. C. I. 1910, **29**, 832.
24. E. P. 14227, 1899; abst. J. S. C. I. 1899, **18**, 730; 1900, **19**, 94, 157.
25. Kunst. 1911, **1**, 62, 170, 226, 250, 290, 349.
26. E. P. 5712, 1911; abst. J. S. C. I. 1912, **31**, 400.
27. Aust. P. 3884, 1900; D. R. P. 114029, abst. Wag. Jahr. 1900, **46**, II, 567.
28. Swiss P. 74339, 1917; abst. C. A. 1917, **11**, 194, 2030.
29. F. P. 373407, 1907.
30. U. S. P. 815600, 1037158, 1090730; E. P. 636, 1910; 15657, 1912; F. P. 417392, Addn. 16144, 1912; D. R. P. 259840, Addn. to D. R. P. 246443.
31. E. P. 6142, 1908. E. P. 15657, 1912; D. R. P. 246443, 1910.
32. U. S. P. 848117; D. R. P. 169679; E. P. 12105, 1905; abst. Kunst. 1913, **3**, 410.

E. Meyer-Zimmerli,¹ P. Orange and L. Benis,² I. Ostromyslenski,³ G. Philipp,⁴ R. Reinecke and E. Knoll,⁵ F. Schnell, G. Myer and E. Hartwich,⁶ Schubert Bros.,⁷ Soc. Thirion and Bonnet,⁸ Soc. Neumann, Marx, Desvaux and Hebert,⁹ F. Steinitzer,¹⁰ O. Streubel,¹¹ A. Tavernier and C. Oulman,¹² J. Thornton and C. Rothwell,¹³ C. Trocquet,¹⁴ J. Turns,¹⁵ H. MacFarland and R. Jay,¹⁶ H. Stobbe,¹⁷ J. Thornton and C. Rothwell,¹⁸ and S. Halen.¹⁹

Condensation products of aldehydes in general which alcoholic and phenolic bodies—both alkyl and aryl—whereby plastic or infusible bodies result of high resistance and great durability, form a series of celluloid substitutes, which in a number of instances have proven superior to the pyroxylin plastics. The development of this subject from the earlier academic researches to the products known as Bakelite, Resinit, Condensite, Redmanol and others, forms a complicated and interesting chapter in pyroxylin plastic technology. These bodies are fully treated in Volume V of this series. Those desiring detailed information on this subject will find abundant data in the publications of J. Abel,²⁰ Act.-Ges. f. Anilinfabr.²¹ J. Albrecht,²² Chemische Fabriken

1. D. R. P. 188546, 1905, abst. Chem. Zentr. 1907, **78**, II, 1820.
2. F. P. 361944, 1905, abst. J. S. C. I. 1907, **26**, 212.
3. J. Russ. Phys. Chem. Soc. 1916, **48**, 1114, abst. C. A. 1917, **11**, 1706.
4. D. R. P. 311876, 1914.
5. F. P. 439570, 1912, abst. C. A. 1912, **6**, 3534.
6. D. R. P. 186997, 1906, abst. Chem. Zentr. 1907, **78**, II, 1820.
7. F. P. 450949, 1912, E. P. 26182, 1912; abst. J. S. C. I. 1913, **32**, 253, 544.
8. F. P. 288793, 1899, abst. Mon. Sci. 1900, **55**, 27.
9. F. P. 308836, 1901.
10. Kunst. 1912, **2**, 1; abst. C. A. 1912, **6**, 2147.
11. E. P. 127, 1879, abst. Chem. Tech. Rep. 1881, **20**, I, 88.
12. F. P. 413152, 1910. Called "Cellulide."
13. D. R. P. 117878, 1901, abst. Jahr. Chem. 1901, **47**, 670; Mon. Sci. 1901, **57**, 165.
14. F. P. 362989, 1906; E. P. 8167, 1906; abst. J. S. C. I. 1907, **25**, 950.
15. E. P. 26093, 1910; abst. J. S. C. I. 1911, **30**, 1398.
16. E. P. 8004, 1915; abst. C. A. 1916, **10**, 2970.
17. J. C. S. 1904, **86**, i, 588, 589, 672; 1905, **88**, i, 857; 1906, **90**, i, 22, 91, 92, 101, 183, 278, 361, 960; 1908, **94**, ii, 339; 1911, **100**, i, 373; Ber. 1905, **37**, 3673.
18. U. S. P. 654688, 654689, 1899; abst. Mon. Sci. 1901, **57**, 126.
19. Kunst. 1914, **4**, 301; abst. C. A. 1915, **9**, 148, 163, 695.
20. Ber. 1892, **25**, 3477, 3488; abst. J. C. S. 1893, **63**, i, 172.
21. F. P. 439087, 1912; abst. J. S. C. I. 1912, **31**, 604. For general information on this subject see L. Andes, Kunst. 1919, **9**, 101, 119, 133.
22. U. S. P. 1205957, 1916; abst. J. S. C. I. 1917, **36**, 91.

K. Albert and L. Berend,¹ Allgemeine Elektrizitäts-Gesellschaft,² O. Anselmino,³ F. Auerbach,⁴ J. Albrecht,⁵ Andés,⁶ V. Andresen,⁷ Asbestwaren-Fabrik Christofitwerke,⁸ W. Arsem,⁹ K. Auwers,¹⁰ J. Aylsworth,¹¹ Badische Anilin and Soda Fabrik,¹² L. Baekeland,¹³

1. E. P. 1260, 1912; abst. Chem. Ztg. 1913, **37**, 104; 15875, 1914 F. P. 436720, 441547. U. S. P. 1040850. D. R. P. 260650, 281930, 254411. 301374. Belg. P. 243027. Swed. P. 40460. Swiss P. 72631. D. R. P. 304384, 1913; abst. J. S. C. I. 1920, **39**, 273-A.
2. D. R. P. 273261, 1912; D. R. Ann. A-21403; abst. C. A. 1914, **8**, 2817. D. R. P. Ann. A-30190, abst. Kunst 1919, **9**, 210.
3. Ber. 1902, **36**, 4099. See P. Alsleben and J. Wulffing, U. S. P. 1018736, 1911.
4. Ber. 1892, **25**, 3485; abst. Jahr. Chem. 1892, **45**, 1122.
5. E. P. 2098, 1913; abst. C. A. 1914, **8**, 2606.
6. Farb. Ztg. 1919, **24**, 1193, abst. C. A. 1919, **13**, 3023.
7. D. R. P. 110154, 1917; abst. C. A. 1918, **12**, 410.
8. D. R. P. Ann. A-18237.
9. U. S. P. 1008770-7, 1914. E. P. 24254, 1912, abst. C. A. 1914, **8**, 2816. J. S. C. I. 1914, **33**, 62, 757.
10. Ber. 1904, **37**, 1470, 3923, 1907, **40**, 2824.
11. U. S. P. 1020593, 1020594, 1020737, 1027794, 1029737, 1033044, 1046137, 1046420, 1047484, 1065495, 1077113, 1087422, 1090439, 1090440, 1092511, 1092512, 1094828, 1098608, 1098609, 1098610, 1102630, 1102631, 1102632, 1102633, 1102634, 1110417, 1111284, 1111285, 1111286, 1111287, 1115766, 1146299, 1146300, 1137374, 1146384, 1146385, 1146386, 1146387, 1146388, 1146389, 1146390, 1146391, 1139470, 1151849, 1197171, 1255500, Re. 13530, 13531, 14530, 14531. Can. P. 160736, 160737, 160738, 160739, 160740. F. P. 429292, 435044, 435955, 436192, 436245, 430807, 441017. E. P. 3496, 3497, 3498, 9559, 12659, 24124, 26029, 1911; 8757, 1913. D. R. P. 258250. D. R. Ann. A-20125, A-20548, A-20707, A-21455, A-21701. Belg. P. 232899, 235360, 240116, 243686. India P. 691, 692, 693, 694, 695, 726, 1911. Ital. P. 34, 377, 1911. New Zeal. P. 30375, 1912. U. S. P. 1135062.
12. E. P. 16245, 1907, 8511, 8512, 21367, 23543, 24216, 24982, 1912; 7137, 1913. F. P. 381664. D. R. P. 207743, 280595, 282850, 303891. D. R. P. Ann. B-66682; abst. Chem. Ztg. 1913, **37**, 189. D. R. P. 307123, 1917; abst. J. S. C. I. 1920, **39**, 377-A.
13. U. S. P. 939966, 941005, 942699, 942700, 942808, 942809, 942852, 942858, 949671, 954666, 1018385, 1019407, 1037719, 1038475, 1057211, 1057319, 1083264, 1085100, 1088677, 1088678, 1133083, 1146045, 1156452, 1160362, 1160363, 1160365, 1187229, 1187239, 1187231, 1187232, 1213144, 1213726, 1200692, 1210265, 1216266, 1217115, 1233298, 1259472, 1259473, 1306681, 1312093. E. P. 1921, 1922, 21566, 1908; 28155, 1910, 26614, 1911, 6293, 6294, 1912; 7284, 1915. D. R. P. 223714, 231280, 226887, 231148, 228639, 233305, 233803, 237790, 281454, 286568. D. R. P. Ann. B-52165, B-60937, B-65940, K-43811. F. P. 386027-8, 386029; Addn. 11628 thereto; 423215, 424459. Aust. P. 20411, 45474, 45487, 45785, 42496, 49009, 52291, 54958, 50950. Ital. P. 96193, 96194. Hung. P. 42040, 43499; Addn. 4432. Belg. P. 205459-60, 213576, 233765. Swiss P. 45487, 45529, 45785, 54511, 51815, 51816; Addn. 11628. Span. P. 43476, 43477. Port. P. 6453, 6454. Can. P. 115479, 117739, 129107, 129108, 139033, 136039, 133997, 136222. Jap. P. 16247, 18600. Mex. P. 8179. Norw. P. 19610, 20411. For method of coating autoclaves and the like with Bakelite, see Arnstädter Malzfabrik H. & S. Windesheim and C. ten Doornkaat-Koolman, D. R. P. 304319, 1916; 305179, 1917; 307609, 1918; abst. J. S. C. I. 1920, **39**, 53-A. See also Erfind. Erfahr. 1919, 41. Swiss P. 56470.

A. Bartels,¹ A. Bacyer and V. Villiger,² Farbenfabriken vorm. Friedrich Bayer & Co.,³ W. Beatty,⁴ F. Beltzer,⁵ L. Berend,⁶ J. Biedermann,⁷ P. Bergall and A. Wulfig,⁸ L. Blumer,⁹ R. Boehm,¹⁰ C. Boehringer und Sohne,¹¹ H. Boerner,¹² R. Bohn,¹³ M. Bottler,¹⁴ M. Boyon,¹⁵ J. Breslauer and A. Pietet,¹⁶ J. Brissonet,¹⁷ The British Thomson-Houston Co., Ltd.,¹⁸ J. Bruhat,¹⁹ A. Brown,²⁰ K. Brown,²¹ K. Brown and S. Kendall,²² J. Buraczewski,²³ J. Buser,²⁴ Chem. Werke vorm. Dr. H. Byk,²⁵ A. Betti,²⁶ M. Callahan,²⁷ N.

1. E. P. 21750, 1910, abst. J. S. C. I. 1911, **30**, 638
2. Ber. 1872, **5**, 280, 1095, 1873, **6**, 220, 1902, **35**, 3013
3. E. P. 26317, 1907. F. P. 350023, 1901, 384425, 1907. U. S. P. 924449. Swiss P. 40639. D. R. P. 201261, 243786, 234744
4. U. S. P. 1139926, 1225748, 1225749, 1225750. E. P. 18822, 18821, 1912, 18499, 1913. F. P. 447647. Belg. P. 252592, 252591, abst. Chem. Ztg. 1913, **37**, 302. Aust. P. 63966, abst. Kunst. 1914, **4**, 257
5. Mon. Ser. 1908, **68**, 618, abst. C. A. 1909, **3**, 721, 1698, 1911, **5**, 3514
6. U. S. P. 952724, 1040850, 1191390, 1205081, 1214114, 1239317. F. P. 436720, 1911. E. P. 15875, 1914, 107205, 1916. D. R. P. 222512, abst. C. A. 1910, **4**, 2884, Zts. ang. Chem. 1910, **23**, 1710, Chem. Zentr. 1910, **81**, II, 122
7. Ber. 1886, **19**, 2375, abst. J. C. S. 1887, **52**, 38
8. E. P. 20093, 1906, abst. J. S. C. I. 1907, **26**, 343
9. E. P. 12880, 1902, 6823, 1903. D. R. P. 172877, 206901, 206906, 217560. Aust. P. 11480. Belg. P. 174819. F. P. 329982
10. Ann. 1903, **329**, 269, abst. J. C. S. 1904, **86**, i, 103
11. D. R. P. 256856, 1910, abst. J. S. C. I. 1913, **32**, 499, C. A. 1913, **7**, 2488
12. Kunst. 1913, **3**, 139. Coating wooden articles, E. Buffum, U. S. P. 1197601, 1916, abst. J. S. C. I. 1916, **35**, 1123
13. U. S. P. 898307, abst. C. A. 1909, **3**, 383
14. Kunst. 1913, **3**, 81, 130, abst. C. A. 1913, **7**, 2314
15. F. P. 443279, 1912, abst. C. A. 1913, **7**, 1823. Product called "Boyont"
16. Ber. 1907, **40**, 3784; abst. J. C. S. 1907, **92**, i, 915
17. D. R. P. 280850, 1898. Called "Cresoform"
18. E. P. 2262, 1902, 6405, 1905, 13916, 1910, 5165, 5167, 1911, 24059, 24254, 1912, 22421, 1913
19. E. P. 129903, 1919, abst. C. A. 1919, **13**, 2084
20. U. S. P. 1212738, 1917, abst. J. S. C. I. 1917, **36**, 396
21. J. Ind. Eng. Chem. 1916, **8**, 1171, abst. C. A. 1917, **11**, 190
22. U. S. P. 1263031, 1918, abst. C. A. 1918, **12**, 1590, J. S. C. I. 1918, **37**, 283-A.
23. Chem. Zentr. 1914, II, 1267, J. C. S. 1915, **108**, i, 674; J. S. C. I. 1915, **34**, 977
24. F. P. 458904, 1913. D. R. P. 273192, 1912. Swiss P. 65927.
25. D. R. P. 252193, 1910; abst. J. S. C. I. 1913, **32**, 36, Kunst. 1912, **2**, 399; C. A. 1912, **6**, 427, Zts. ang. Chem. 1912, **25**, 2500. See also D. R. P. 193136; abst. Wag. Jahr. 1908, **54**, II, 73; Chem. Zentr. 1908, **79**, I, 1002.
26. Gaz. chim. ital. 1900, **30**, 310; 1901, **31**, 377; 1903, **33**, 17, 27; 1906, **36**, 388.
27. U. S. P. 1091732, 1091627, 1091628, 1108329, 1108330, 1108331, 1108332. E. P. 24059, 24060, 1912; 3271, 22358, 1913.

Caro,¹ A. Caroselli,² M. Chappell,³ A. Chanard,⁴ H. Cathelineau and A. Fleury,⁵ Chem. Fabrik Griesheim-Elektron,⁶ L. Claisen,⁷ A. Classen,⁸ W. Claypoole,⁹ A. Claus and E. Trainer,¹⁰ G. Clowes,¹¹ C. Coffignier,¹² W. Cohoe,¹³ G. Cohn,¹⁴ L. Collardon,¹⁵ Commercial Products Co.,¹⁶ Compagnie Generale D'Electricite,¹⁷ K. Connell,¹⁸ A. Cornelson and S. Kostanecki,¹⁹ C. Counciler,²⁰ E. Crumiere & Co.,²¹ Damard Lacquer Co. and Potter,²² P. Dankwortt,²³ S. Davidson,²⁴ E. Dawson,²⁵ Deutsch Koloniale Gerb-u. Farbstoff-Ges.,²⁶ E. Diesser,²⁷ G. Diesser,²⁸ S. Diesser,²⁹ R. Dior,³⁰ P. Dobriner,³¹ A. Dubosc,³² H. Dunning,³³ E. I. du Pont de Nemours Powder

1. Ber. 1892, **25**, 939; 1893, **26**, 254; abst. J. C. S. 1893, **64**, i, 274.
2. U. S. P. 1031837, 1086139; abst. C. A. 1912, **6**, 2696; 1914, **8**, 1215.
3. U. S. P. 1102473, 1914; abst. C. A. 1914, **8**, 2926.
4. F. P. 445843, 1912; abst. C. A. 1913, **7**, 1927.
5. F. P. 354942, 1905, and Add. 4898; abst. J. S. C. I. 1905, **24**, 1169, 1226.
6. Swed. P. 41723, 1916; abst. C. A. 1917, **11**, 2030.
7. Ber. 1887, **20**, 655; 1886, **19**, 3316; Ann. 1884, **223**, 137; 1886, **237**, 261.
8. D. R. P. 92259, 1896, abst. Jahr. Chem. 1897, **50**, 1516; 1898, **51**, 1242.
9. E. P. 2122, 1908. F. P. 394614. Belg. P. 210904, 1908.
10. Ber. 1886, **19**, 3004; abst. J. C. S. 1887, **52**, 231.
11. Ber. 1899, **32**, 2841; abst. J. C. S. 1900, **78**, ii, 56.
12. Rev. chim. ind. 1917, **26**, 201; abst. C. A. 1918, **12**, 96.
13. E. P. 23573, 1910; abst. C. A. 1912, **6**, 1553; J. S. C. I. 1912, **31**, 86.
14. Chem. Ztg. 1916, **40**, 725; abst. J. S. C. I. 1916, **35**, 1025.
15. E. P. 9040, 1913, 1598, 1912. F. P. 453393. D. R. P. 274875. Belg. P. 252906, 252908. Holl. P. 1380, 1917. Swiss P. 63821. Hung. P. Appl. 2285, 1913.
16. Swiss P. 50078, 1909. E. P. 4154, 1909; abst. C. A. 1910, **4**, 2581.
17. F. P. 406686, 1909; abst. J. S. C. I. 1910, **29**, 577.
18. Surgery, Gynecology and Obstetrics, 1918, **27**, 81; J. Amer. Med. Assoc. **71**, 688; C. A. 1918, **12**, 2042.
19. Ber. 1896, **29**, 240; abst. J. C. S. 1896, **70**, i, 240.
20. Chem. Ztg. 1896, **20**, 585, abst. Jahr. Chem. 1896, **49**, 1186.
21. F. P. 464344, 1913.
22. E. P. Appl. 11601, 12312, 21352, 1918, E. P. 131112; abst. J. S. C. I. 1919, **38**, 834-R.
23. Ber. 1909, **42**, 4163, abst. J. C. S. 1909, **96**, i, 938.
24. E. P. 11470, 1912; abst. Kunst. 1913, **3**, 453.
25. U. S. P. 1085112, 1914; abst. J. S. C. I. 1914, **33**, 325.
26. E. P. 8818, 1914. F. P. 471924, 1914, abst. J. S. C. I. 1915, **34**, 438, 1155.
27. E. P. 9184, 1914.
28. E. P. 11160, 1908; 8402, 16615, 16616, 1912. F. P. 446348, 446349. Swiss P. 61423, 62592. Aust. P. 63438.
29. D. R. P. 236302, 236303, 246038, 250281.
30. E. P. 124010, 1919; abst. J. S. C. I. 1919, **38**, 330-A.
31. Zts. anal. Chem. 1901, **40**, 667. See Endemann, Bull. of Pharm. **11**, 365; Zts. allg. oest. Apothekerver. **51**, 599.
32. Caout. et Gutta-p. 1919, **16**, 9709; abst. C. A. 1919, **13**, 997.
33. Amer. J. Pharm. 1913, **85**, 453; abst. J. S. C. I. 1913, **32**, 1028.

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- 1 E. P. 22621, 22626, 1912; abst. C. A. 1914, **8**, 992; Kunst. 1914, **4**, 154
- 2 E. P. Appl. 13350, 1919; abst. J. S. C. I. 1919, **38**, 448 A.
- 3 E. P. 15945, 1911. See E. P. 15914, 1894.
- 4 U. S. P. 1146413, 1283706 E. P. 607, 1913
- 5 F. P. 478884, 1916, abst. J. S. C. I. 1916, **35**, 1164, C. A. 1916, **10**, 2285
- 6 D. R. P. 276434, 1913; abst. J. S. C. I. 1914, **33**, 1021
- 7 Kunst. 1916, **6**, 45; abst. C. A. 1916, **10**, 1277.
- 8 E. P. 117016; abst. J. S. C. I. 1918, **37**, 554-A, C. A. 1918, **12**, 2451.
- 9 J. Ind. Eng. Chem. 1916, **8**, 406, abst. J. S. C. I. 1916, **35**, 698 J. Ind. Eng. Chem. 1916, **8**, 797, abst. Chem. News, 1917, **116**, 104; Kunst. 1919, **9**, 192
- 10 U. S. P. 1043682, 1912, abst. C. A. 1913, **7**, 261.
- 11 Ann. 1885, **231**, 37, F. Engelmann. D. R. P. Anm. E. 23046, P. Esholz and J. Altendorf.
- 12 Wien. Akad. Ber. 1882, **86**, I, 557, Monatsh. 1882, **3**, 637; J. C. S. 1883, **44**, 61
- 13 Ber. 1879, **11**, 283; abst. Jahr. Chem. 1878, **31**, 591.
- 14 E. P. 15517, 1905, 5533, 1913 F. P. 350180, 361539. Belg. P. 192590.
- 15 F. P. 335584, 341013, 345398, abst. J. S. C. I. 1904, **23**, 873.
- 16 U. S. P. 491880, 1893; abst. J. A. C. S. 1893, **15**, 118.
- 17 Kunst. 1912, **2**, 151, 164, abst. C. A. 1912, **6**, 2544.
- 18 E. P. 6724, 1905. See E. P. 4108, 1880, 3539, 1882; 6732, 1880; 13701, 1900.
- 19 Compt. rend. 1901, **132**, 787, 1903, **137**, 858, 1904, **138**, 282.
- 20 U. S. P. 1284295, 1284296, 1284297, 1284298, 1284644; abst. C. A. 1919, **13**, 169, 170
- 21 U. S. P. 1119592, 1914, abst. C. A. 1915, **9**, 179, J. S. C. I. 1915, **34**, 40. See also K. Fuchs, D. R. P. Anm. F. 42827, abst. Kunst. 1919, **9**, 154.
- 22 Rev. prod. Chim. 1918, **21**, 116, abst. C. A. 1918, **12**, 1839
- 23 E. P. 17135, 27236, 1898, abst. J. S. C. I. 1898, **17**, 820, 1899, **18**, 98, 544, 577, 1180; 1900, **19**, 41, 69.
- 24 U. S. P. 1098728, 1914; E. P. 6402, 1904, 4363, 1907; 5165, 5167, 1911; 6405, 24059, 24060, 24254, 24255, 22449, 23776, 1912; 3271, 3566, 5448, 8417, 9985, 22421, 22544, 1913.
- 25 U. S. P. 924449, 1909; abst. C. A. 1909, **3**, 2242.
- 26 U. S. P. 1277904; abst. C. A. 1918, **12**, 2440.
- 27 Chem. Ztg. 1898, **22**, 374; 420, abst. Jahr. Chem. 1898, **51**, 1691.
- 28 U. S. P. 1114981, 1914; 1168626, 1916; Re. 14087, 1916; 1188439, 1916; 1228428, 1230829, 1230830; E. P. 412, 1909; 6363, 1912. India P. 59, 1909.
- 29 Ber. 1904, **37**, 315; abst. J. C. S. 1904, **86**, i, 262.

L. Grognot,¹ N. Grinstein,² J. Gesell und F. Schlesinger,³ O. Günthel,⁴ A. Guyot and A. Haller,⁵ K. Hagendorf,⁶ K. Hagendorf and A. Breslauer,⁷ E. Halbleib and T. Lee,⁸ E. Hammond,⁹ J. Handy,¹⁰ A. Hantzsch, A.¹¹ Heinemann,¹² E. Heintschel,¹³ G. Heller and G. Fiesselmann,¹⁴ L. Helm,¹⁵ E. Hemming and Hemming Manufacturing Co.,¹⁶ G. Henning,¹⁷ F. Henschke,¹⁸ J. Hertkorn,¹⁹ J. Hewitt and A. Turner,²⁰ H. Hildebrandt,²¹ T. Hiltermann,²² R. Hirsch,²³ K. Hofmann,²⁴ F. Hoffmann-La Roche and Co.,²⁵ A. Horn,²⁶ P. Horn,²⁷ H. Hosaeus,²⁸ K. Howell,²⁹ A. Hutchinson,³⁰ Ioco Proofing Co., Nuttall, and Vickers, Ltd.,³¹ B. Lab-

1. U. S. P. 891436, 906219, 1908, Can. P. 116133.
2. U. S. P. 1044169, 1912, E. P. 101636, 1916; D. R. P. 250356, 1910.
3. D. R. P. Ann. G. 30392, 1913, abst. Kunst. 1914, **4**, 120, 177. Chem. Ztg. 1914, **38**, 541.
4. D. R. P. 273506, 1911, abst. C. A. 1915, **9**, 1232.
5. Bull. Soc. Chim. 1901, **25**, 752, 1904, **31**, 530.
6. D. R. P. 274179, 1913, abst. J. S. C. I. 1914, **33**, 838.
7. D. R. P. 288347, 1914; Add. to D. R. P. 274179; abst. J. S. C. I. 1914, **33**, 838, 1916, **35**, 358.
8. U. S. P. 1274411; abst. C. A. 1918, **12**, 1950.
9. Machinery, 1918, 187.
10. U. S. P. 1287299, 1918, abst. J. S. C. I. 1919, **38**, 151-A; C. A. 1919, **13**, 367.
11. Ber. 1885, **18**, 2579; abst. J. C. S. 1886, **50**, 77.
12. U. S. P. 1176056, E. P. 10353, 1912, 28187, 1913, 9390, 11394, 1914. Holl. P. 2806, abst. Kunst. 1919, **9**, 123.
13. Ber. 1905, **38**, 2878, abst. J. C. S. 1905, **88**, i, 809.
14. D. R. P. 117924. Ann. 1902, **324**, 118.
15. E. P. 25216, 25217, 1907, F. P. 392395, Addn. 10415, Aust. P. 38951, abst. Kunst. 1914, **4**, 269.
16. U. S. P. 1118005, 1914, E. P. 21264, 1914, abst. C. A. 1916, **10**, 1084.
17. D. R. P. 99610, 1898, abst. Jahr. Chem. 1898, **51**, 1241. Ann. 1887, **240**, 203.
18. D. R. P. 157553, 157554, 1903, Aust. P. 25223, abst. Chem. Zentr. 1905, **76**, i, 414.
19. E. P. 17220, 1908, abst. J. S. C. I. 1909, **28**, 1006.
20. Ber. 1901, **34**, 202, abst. J. C. S. 1901, **60**, i, 207.
21. E. P. 375737, 1907, U. S. P. 876311, 1908. N. Erfind. Erfah. 1909, **36**, 591.
22. E. P. 117857, 1917, abst. J. S. C. I. 1918, **37**, 554-A; C. A. 1918, **12**, 2669. Kunst. 1919, **9**, 94.
23. Ber. 1891, **24**, 324, abst. J. C. S. 1891, **60**, 554.
24. Ber. 1893, **26**, 1139, abst. J. C. S. 1893, **64**, i, 472.
25. D. R. P. 200064, 1907, abst. J. S. C. I. 1908, **27**, 999.
26. U. S. P. 989476, abst. C. A. 1909, **3**, 383. G. Hopp, U. S. P. 1156081; abst. Kunst. 1919, **9**, 150.
27. E. P. 28109, 1907, F. P. 385153, 1907. D. R. P. 189947; abst. Wag. Jahr. 1907, **53**, II, 545, Zts. ang. Chem. 1908, **21**, 260; Chem. Zentr. 1908, **79**, i, 82. D. R. P. 220772, 1909; abst. J. S. C. I. 1910, **29**, 640.
28. Ber. 1892, **25**, 3213; abst. J. C. S. 1893, **64**, i, 100.
29. U. S. P. 1068728, 1913, abst. J. S. C. I. 1914, **33**, 799.
30. Ber. 1891, **24**, 173; abst. J. C. S. 1890, **57**, 957; 1891, **60**, 561.
31. E. P. appl. 18827, 1919, abst. J. S. C. I. 1919, **38**, 609-A.

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1. J. A. C. S. 1913, **35**, 811, abst. C. A. 1913, **7**, 3035.
2. Elec. J. 1919, **16**, 326, abst. C. A. 1919, **13**, 2162. U. S. P. 1323284.
3. Ber. 1874, **7**, 1197; abst. J. C. S. 1875, **23**, 159.
4. U. S. P. 1200731, abst. C. A. 1916, **10**, 3169; J. S. C. I. 1916, **35**, 1226. U. S. P. 1171725; abst. C. A. 1916, **10**, 1104. U. S. P. 1209165, 1916; abst. J. S. C. I. 1917, **36**, 225; C. A. 1917, **11**, 710.
5. Ber. 1898, **31**, 143; abst. J. C. S. 1898, **74**, i, 258.
6. E. P. 9292, 1914; abst. C. A. 1915, **9**, 2819; J. S. C. I. 1915, **34**, 623.
7. Kunst. 1913, **3**, 301; 1914, **4**, 268, abst. C. A. 1913, **7**, 3069.
8. Aust. P. 54262; abst. Kunst. 1912, **2**, 393.
9. U. S. P. 1284363, abst. C. A. 1919, **13**, 170.
10. U. S. P. 1218568, 1917; abst. J. S. C. I. 1917, **36**, 462.
11. U. S. P. 1241738, abst. J. S. C. I. 1917, **36**, 1185. D. R. P. 281687, 1913; abst. J. S. C. I. 1915, **34**, 623.
12. U. S. P. 1143714, abst. C. A. 1915, **9**, 2318.
13. Ann. 1896, **283**, 131, abst. J. C. S. 1896, **70**, i, 286.
14. D. R. P. 219200, 214194, 219728, 222543. E. P. 28009, 1907. E. P. 27096, 1908. E. P. 6429, 1910, 6430, 1910. U. S. P. 965823. Aust. P. 45474. F. P. 395657, 397051. Swiss P. 41910, 1907, 45913, 1908. Belg. P. 204811, 1907; 212194, 1908. Papier Ztg. 1909, **34**, 3212.
15. D. R. P. 253437, 1912; abst. C. A. 1913, **7**, 712.
16. Ber. 1883, **16**, 2097; abst. J. C. S. 1884, **46**, 56.
17. Ber. 1899, **32**, 1030; abst. J. C. S. 1899, **76**, i, 523.
18. Ber. 1896, **29**, 1488, abst. J. C. S. 1896, **70**, i, 556, 688.
19. E. P. 76, 1914; abst. J. S. C. I. 1915, **34**, 972.
20. D. R. P. 280648; abst. C. A. 1915, **9**, 1849; Kunst. 1915, **5**, 9. Chem. Ind. 1914, **37**, 559. Kunst. 1914, **4**, 298; 1915, **5**, 196.
21. E. P. 28491, 1910. F. P. 426568, 1911. Aust. P. Auf. A-7426, 10.
22. F. P. 468879, 1913, abst. J. S. C. I. 1914, **33**, 974; C. A. 1915, **9**, 2297.
23. E. P. 12822, 1914; abst. J. S. C. I. 1915, **34**, 956.
24. E. P. 5169, 1906; abst. J. S. C. I. 1907, **26**, 407.
25. E. P. 6800, 1894. J. prakt. Chem. 1894, **158**, 223.
26. U. S. P. 965823, 1910. See also Zts. ang. Chem. 1909, **22**, 1598. Chem. Ztg. 1913, **37**, 733, 750. J. S. C. I. 1913, **32**, 559. Kunst. 1912, **2**, 199; 1913, **3**, 259.
27. D. R. P. 155630; abst. Zts. ang. Chem. 1905, **18**, 73.
28. Ber. 1878, **11**, 1434; 1883, **16**, 2858.
29. Ber. 1876, **9**, 800; abst. J. C. S. 1876, **30**, 414.
30. Ber. 1904, **37**, 1171, 2728; abst. J. C. S. 1904, **86**, i, 764.
31. D. R. P. 259840, 246443. F. P. 417392 and addn. of June 28,

- A. MacFarlane and H. Stanbury,¹ Möller and Linsert,² O. Manasse,³ J. Marcusson,⁴ G. Marks,⁵ A. Maschke,⁶ H. Matheson,⁷ G. Matsumoto,⁸ G. Mauthner,⁹ J. McIntosh,¹⁰ J. McCoy,¹¹ L. McCulloch,¹² W. McPherson,¹³ A. Mehner,¹⁴ S. de Medveczky,¹⁵ E. ter Meer,¹⁶ Farbwerke vorm. Meister, Lucius & Bruening,¹⁷ E. Merk,¹⁸ W. Merckens and H. Manissadjian,¹⁹ F. Meyer,²⁰ A. Michael,²¹ A. Michael and J. Ryder,²² R. Möhlau and L. Kahl,²³ R. Moehlau and P. Koch,²⁴ R. Moehlau and E. Strohbach,²⁵ A. 1912. E. P. 636, 1910; 15657, 1912. Aust. P. 47237, 54719. Aust. P. Auf. A-6211/11.
32. F. P. 387002, 1908; abst. Mon. Sci. 1909, **71**, 109.
 33. E. P. 1330, 1908; abst. J. S. C. I. 1908, **27**, 643.
 34. E. P. 2377, 1903. 22122, 1908. 25318, 1908. F. P. 387082, 1908. D. R. P. 203847, 233320. Aust. P. 39440, 1909.
 35. E. P. Appl. 9537, 1919; abst. J. S. C. I. 1919, **38**, 310-A.
 36. U. S. P. 735278, 1903. E. P. 10218, 1902. Aust. P. 14037. D. R. P. 140552. F. P. 320991.
 37. J. Russ. Phys. Chem. Soc. 1908, **40**, 466; abst. C. A. 1909, **3**, 884.
 1. E. P. 3678, 1898; abst. J. S. C. I. 1898, **17**, 298, 1212; 1899, **18**, 154.
 2. E. P. 20223, 1903; abst. J. S. C. I. 1903, **22**, 1306.
 3. Ber. 1902, **35**, 3847. Ber. 1894, **27**, 2409. U. S. P. 526786, 1894.
 4. Chem. Ztg. 1919, **43**, 109, 122; abst. J. S. C. I. 1919, **38**, 329-A.
 5. Belg. P. 232890, 1911.
 6. E. P. 1155, 1914, abst. J. S. C. I. 1914, **33**, 594.
 7. U. S. P. 1151113, 1915; 1309581, 1919.
 8. J. C. I. Japan, 1915, **18**, 434; abst. C. A. 1915, **9**, 2317; J. S. C. I. 1915, **34**, 1104; Ann. Rep. S. C. I. 1916, **1**, 191.
 9. D. R. P. 247181; abst. Kunst. 1914, **4**, 269, Zts. ang. Chem. 1912, **25**, 1600; Wag. Jahr. 1912, **58**, II, 99.
 10. U. S. P. 1260292; abst. C. A. 1918, **12**, 1843. U. S. P. 1236959, 1236960, 1236961; abst. C. A. 1917, **11**, 2949.
 11. U. S. P. 1194201; abst. C. A. 1916, **10**, 2534. U. S. P. 1253404; abst. C. A. 1918, **12**, 770; J. S. C. I. 1918, **37**, 158-A. U. S. P. 1253261; abst. J. S. C. I. 1918, **37**, 158-A. U. S. P. 1253262; abst. J. S. C. I. 1918, **37**, 158-A. U. S. P. 1260627; abst. C. A. 1918, **12**, 1916; J. S. C. I. 1918, **37**, 154-A. U. S. P. 1286372, 1918; abst. J. S. C. I. 1919, **38**, 151-A. E. P. 13657, 1913; abst. C. A. 1914, **8**, 3867.
 12. U. S. P. 1286043; abst. C. A. 1919, **13**, 252.
 13. Ber. 1895, **28**, 2414; abst. J. C. S. 1896, **70**, i, 27.
 14. J. prakt. Chem. 1901, **171**, 243; abst. Chem. Centr. 1901, **72**, I, 1369.
 15. E. P. 27283, 1910; abst. J. S. C. I. 1912, **31**, 67.
 16. Ber. 1874, **7**, 1200; abst. J. C. S. 1875, **28**, 158.
 17. D. R. P. 91503, 1897; abst. Jahr. Chem. 1901, **54**, 1285.
 18. D. R. P. 78910, 1894; 88082, 1895; abst. Chem. Centr. 1895, **66**, I, 719; 1896, **67**, II, 1016.
 19. E. P. 8647, 1910; abst. J. S. C. I. 1911, **30**, 616. F. P. 414679, 1910; abst. J. S. C. I. 1910, **29**, 1199. Aust. P. 47679.
 20. D. R. P. 294107, 1916; abst. J. S. C. I. 1916, **35**, 1164.
 21. J. prakt. Chem. 1898, **57**, 334. Ber. 1887, **20**, 1573. See also Ber. 1886, **19**, 3316.
 22. Ber. 1886, **19**, 1388; abst. J. C. S. 1886, **50**, 695; 1887, **52**, 723.
 23. Ber. 1898, **31**, 259; abst. J. C. S. 1898, **74**, i, 260, 261.
 24. Ber. 1894, **27**, 2887; abst. J. C. S. 1895, **68**, i, 46.
 25. Ber. 1900, **33**, 804; abst. J. C. S. 1900, **78**, i, 368.

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1. F. P. 429576; abst. Mon. Sci. 1913, **79**, 47.
2. Dan. P. 21606, 1916; abst. C. A. 1917, **11**, 278. F. P. 483015, 1917. D. R. P. 248484, 1910. Pat. P. 8572. Aust. P. Ann. 7140, 1305/13; Hung. P. Appl. N-1175, 1911, H-4930, 1913; abst. Chem. Ztg. 1913, **37**, 302, 1539, 1912, **36**, 327, 731.
3. E. P. 118270, abst. J. S. C. I. 1919, **38**, 111 A. C. A. 1919, **13**, 271.
4. E. P. 4649, 4651, 1911; abst. J. S. C. I. 1912, **31**, 150, 324.
5. D. R. P. 302158, 1915; abst. J. S. C. I. 1918, **37**, 381 A. See also C. Nash, U. S. P. 1343575, abst. C. A. 1920, **14**, 2401.
6. F. P. 419061. D. R. P. 237743, abst. Wag. Jahr. 1911, **57**, II, 548, C. A. 1912, **6**, 1687, Kunst. 1911, **1**, 212.
7. F. P. 348653. Addn. of March 1, 1904 to F. P. 348653, abst. J. S. C. I. 1905, **24**, 682.
8. D. R. P. 173633, 252705, 253517, 253518, 253519. See also D. R. P. 129167, 121901.
9. Chem. Ztg. 1892, **16**, 185.
10. E. P. 4877, 1912; abst. C. A. 1913, **7**, 2864.
11. U. S. P. 1284432; abst. C. A. 1919, **13**, 170.
12. E. P. 4663, 1913; abst. C. A. 1914, **8**, 2497.
13. U. S. P. 1222980, 1917; abst. J. S. C. I. 1917, **36**, 603.
14. J. Russ. Phys. Chem. Soc. 1916, **48**, 1114, abst. J. S. C. I. 1917, **36**, 727.
15. Ber. 1893, **26**, 155, abst. J. C. S. 1893, **64**, i, 269.
16. D. R. P. 234806, 1908, abst. Kunst. 1911, **1**, 415, Zts. ang. Chem. 1911, **24**, 1336; Chem. Zentr. 1911, **82**, II, 118, C. A. 1911, **5**, 3175. E. P. 19777, 1909. F. P. 402907, 1908; abst. J. S. C. I. 1909, **28**, 1320; Kunst. 1914, **4**, 269. Aust. P. 51800, 1911; abst. Chem. Ztg. 1912, **36**, 10.
17. Aust. P. Appl. 8096-09, abst. C. A. 1912, **6**, 2010.
18. Ber. 1915, **48**, 934; abst. C. A. 1915, **9**, 2253.
19. E. P. 7370, 1914; abst. J. S. C. I. 1915, **34**, 436.
20. U. S. P. 932318, 1909; abst. C. A. 1909, **3**, 2619.
21. Belg. P. 233101, 1911. F. P. 426285, 1911.
22. U. S. P. 1147264, 1915, abst. J. S. C. I. 1915, **34**, 914.
23. E. P. 13431, 1912; abst. C. A. 1913, **7**, 4087, Kunst. 1913, **3**, 395; J. S. C. I. 1913, **32**, 835. E. P. 18281, 1912; abst. C. A. 1914, **8**, 434; J. S. C. I. 1913, **32**, 918. E. P. 18287, 1912; abst. J. S. C. I. 1913, **32**, 983; C. A. 1914, **8**, 434. E. P. 14490, 1915; abst. J. S. C. I. 1916, **35**, 1228; C. A. 1917, **11**, 878. E. P. 20988, 1914; abst. C. A. 1916, **10**, 958; J. S. C. I. 1915, **34**, 1154. E. P. 21401, 1910; abst. J. S. C. I. 1911, **30**, 1072; E. P. 25830, 1913. F. P. 420404, 1910; abst. J. S. C. I. 1911, **30**, 373; Mon. Sci. 1913, **79**, 89. F. P. 447969, 1912; abst. J. S. C. I. 1913, **32**, 436; C. A. 1913, **7**, 2488; Kunst. 1914, **4**, 269. D. R. P. 263109; abst. C. A. 1913, **7**, 4088; Kunst. 1913, **3**, 300, 357. D. R. Ann. P-24551, 27088, 27589, 27980, 30665, 31750, 1909. U. S. P. 1210982; abst. C. A. 1917, **11**, 710; J. S. C. I. 1917, **36**,

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225. U. S. P. 1211227; abst. C. A. 1917, **11**, 693; J. S. C. I. 1917, **36**, 151. U. S. P. 1216728; abst. C. A. 1917, **11**, 1734; J. S. C. I. 1917, **36**, 396. Holl. P. 1859, 1917; abst. C. A. 1917, **11**, 1734. Swed. P. 41636, 1916; abst. C. A. 1917, **11**, 2050. Belg. P. 246523, 1912. Swiss P. 62587, 1912; abst. C. A. 1914, **8**, 2270. See also Kunst 1913, **3**, 382; abst. C. A. 1914, **8**, 582; Chem. Ztg. 1913, **37**, 1233; Farben Ztg. **19**, 212. See also D. R. P. 310894; abst. Kunst. 1919, **9**, 136.
1. E. P. 131112, 1918; abst. J. S. C. I. 1919, **38**, 834-A; C. A. 1920, **14**, 103.
 2. U. S. P. 1310291; abst. C. A. 1919, **13**, 2429.
 3. F. P. 386011, 1908; abst. J. S. C. I. 1908, **27**, 695, 696, 704, 740, 761.
 4. E. P. 16528, 1908; F. P. 390713, 392978, 1907; Can. P. 115132, 1908, Swiss P. 43633; Belg. P. 209675, 1908. D. R. P. 210012; abst. Kunst. 1914, **4**, 268; C. A. 1909, **3**, 2244; Zts. ang. Chem. 1909, **22**, 1420; Chem. Zentr. 1909, **80**, II, 81; Chem. Ztg. Rep. 1909, **33**, 320; Chem. Ind. 1909, **32**, 341; Wag. Jahr. 1909, **55**, II, 552.
 5. E. P. 15486, 1906; abst. J. S. C. I. 1907, **26**, 58.
 6. U. S. P. 1107703, 1188014, 1206333, 1242592, 1242593, 1261615, 1310087, 1310088; abst. C. A. 1914, **8**, 3377; 1917, **11**, 710; 1918, **12**, 209, 1601; 1919, **13**, 2429. J. S. C. I. 1916, **35**, 933; 1917, **36**, 225, 1242; 1918, **37**, 433-A. E. P. 9291, 1914; 119252, 119253. Can. P. 160682, 160683, 181464, 181465. L. Redman, A. Weith and F. Brock, J. Ind. Eng. Chem. 1914, **6**, 3, 205, 263; 1916, **8**, 473, 1077, 1917, **9**, 388. U. S. P. 1339134; abst. C. A. 1920, **14**, 1878; J. S. C. I. 1920, **39**, 460-A. Can. P. 181464, 181465, 184506, 1918. E. P. 119252, 119253, 1919; abst. Kunst. 1919, **9**, 94.
 7. E. P. 10055, 1915. F. P. 479319, 1915; abst. J. S. C. I. 1917, **36**, 1185; C. A. 1916, **10**, 2286.
 8. F. P. 468241, 1914. Holl. P. 2187, 1917; abst. Mon. Sci. 1916, **83**, 71.
 9. Ann. 1863, **128**, 179; abst. Jahr. Chem. 1863, **16**, 349.
 10. E. P. Appl. 18789, 1919. E. P. 130608, 1919; abst. C. A. 1920, **14**, 22.
 11. Farb. Ztg. **17**, 936; abst. C. A. 1912, **6**, 2852.
 12. J. prakt. Chem. 1905, (N. F.) **180**, 315; abst. J. C. S. 1905, **88**, i, 883.
 13. D. R. P. 265915, 1913; abst. C. A. 1914, **8**, 443.
 14. F. P. 380515, 1907.
 15. E. P. 27764, 1910. D. R. P. 245149, 1910; abst. C. A. 1912, **6**, 2548; Kunst. 1912, **2**, 194.
 16. D. R. P. 193136, 219570; abst. Wag. Jahr. 1910, **56**, II, 584; Zts. ang. Chem. 1910, **23**, 816; Chem. Zentr. 1910, **81**, I, 974; Chem. Ztg. Rep. 1910, **34**, 172; Chem. Ind. 1910, **33**, 234; Chem. Zts. 1910, **9**, 1884.
 17. Kunst. 1912, **2**, 92; abst. C. A. 1912, **6**, 1372.
 18. D. R. P. 88114, 278486; abst. Chem. Centr. 1896, **67**, II, 1072; Zts. ang. Chem. 1914, **27**, II, 640.
 19. Ber. 1906, **39**, 4183; abst. J. C. S. 1907, **92**, i, 26.
 20. Ber. 1880, **13**, 2342; 1881, **14**, 574. Schmitz & Co., E. P. 3053, 1914.
 21. D. R. P. 175352, 1905; abst. Zts. ang. Chem. 1907, **20**, 2048.
 22. F. P. 3789, 1907; abst. J. S. C. I. 1907, **26**, 712.
 23. M. Scholtz, Ber. 1895, **28**, 1726. M. Scholtz and L. Huber, Ber. 1895, **28**, 1726, 1899, **32**, 1935; 1904, **37**, 395.

C. Schotten,¹ A. Schwar,² E. Schweitzer,³ G. Scott,⁴ Societe de la Manufacture D'Indiennes E. Zündel,⁵ W. Stadler,⁶ A. Steiner,⁷ H. Steinerz and F. von Schaller,⁸ F. Steinitzer,⁹ C. Steinmetz,¹⁰ A. Stephan,¹¹ W. Stevenson,¹² E. Stiasny,¹³ A. Smith,¹⁴ R. Stoerner and K. Behn,¹⁵ H. Stockhausen and R. Gruhl,¹⁶ W. Story,¹⁷ E. Sweetland, F. Manning and W. Hilpert,¹⁸ C. Trocquet,¹⁹ K. Tarassoff,²⁰ K. Tarassoff and P. Shestakoff,²¹ H. Terrisse,²² M. Thiele,²³ O. Thomas,²⁴ K. Lingner,²⁵ F. Tiemann,²⁶ W. Tischtschenko,²⁷ C. Townsend,²⁸ I. Traube,²⁹ W. Trzcinski,³⁰ Vereinigte

1. Ber. 1878, **11**, 784; abst. J. C. S. 1878, **34**, 877
2. D. R. P. 214399, 216107; abst. Chem. Zentr. 1909, **80**, II, 1516, 2056.
3. Elec. World, 1918, **72**, 52; abst. C. A. 1918, **12**, 1856.
4. E. P. 128477, 1918; abst. C. A. 1919, **13**, 2984
5. E. P. 714, 1913. F. P. 452677, 1912; abst. J. S. C. I. 1913, **32**, 653
6. D. R. P. 221493, 1909; abst. J. S. C. I. 1910, **29**, 578.
7. Ber. 1878, **11**, 247; abst. J. C. S. 1878, **34**, 507
8. F. P. 460296, 1913; abst. J. S. C. I. 1914, **33**, 92
9. Kunst. 1915, **5**, 109; Zts. ang. Chem. 1915, **28**, 460, J. S. C. I. 1915, **34**, 1153.
10. U. S. P. 1215072, 1917; abst. J. S. C. I. 1917, **36**, 396 U. S. P. 1049005, 1912. E. P. 21987, 1911.
11. U. S. P. 812608, 1906. F. P. 345308, 1904. Belg. P. 178849, 1904
12. D. R. P. 157553. Aust. P. 25223.
13. U. S. P. 1205230, 1298816; abst. C. A. 1919, **13**, 1248, 1752
14. J. S. C. I. 1913, **32**, 775; abst. C. A. 1913, **7**, 3853
15. U. S. P. 643012, 1900. E. P. 19016, 1909. D. R. P. 112685 Aust. P. 3198.
16. Ber. 1901, **34**, 2455; abst. J. C. S. 1901, **80**, i, 726.
17. U. S. P. 1150642, 1915. E. P. 14481, 1913. F. P. 460075, 1913 Belg. P. 261327. Swiss P. 66513. D. R. P. 277653, 281262. Port P. 8201/03, 1912. Russ. P. 56571, 1913. Hung. P. Appl. 5679, 1911.
18. E. P. 8875, 1905. D. R. P. 173990, 1905. F. P. 353995, 1905, and Add. 9861. Belg. P. 184272, 1905, 210965, 1908. Aust. P. 30844, 1907 Dan. P. 8817, 1906. See D. R. P. 112865, 140552 Ber. 1872, **5**, 1905, 1891, **19**, 3009.
19. U. S. P. 1292535, 1919; abst. J. S. C. I. 1919, **38**, 276-A.
20. E. P. 8167, 1906. F. P. 362989, 1906; abst. J. S. C. I. 1906, **25**, 825, 950.
21. U. S. P. 1187869, 1216515, 1216516, 1235507. E. P. 528, 6716, 7560, 1914; 102751, 1916. F. P. 469832, 470810, 1914. Hoff. P. 1793, 4796, 1917. Aust. P. 11005, and Add. 2361.
22. U. S. P. 1237579, 1252507, 1918. E. P. 102635, 104887.
23. E. P. 23054, 23055, 1914; abst. J. S. C. I. 1916, **35**, 57.
24. D. R. P. 289565, 1911; abst. C. A. 1916, **10**, 2626. D. R. P. Ann. T-16876; abst. Chem. Ztg. 1913, **37**, 163.
25. E. P. 28069, 1910. F. P. 425618, 1911; abst. J. S. C. I. 1912, **31**, 33.
26. E. P. 22122, 1908; abst. J. S. C. I. 1909, **28**, 468.
27. Ber. 1875, **8**, 1123. 1876, **9**, 415. 1886, **19**, 359. 1891, **24**, 2854.
28. Jour. Russ. Phys. Chem. Soc. 1906, **38**, 432; abst. Chem. Centr. **1906**, **77**, II, 1552.
29. U. S. P. 1146214, 1915; 1273954, 1918; abst. C. A. 1915, **9**, 2432;

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J. S. C. I. 1915, **34**, 914.

29. D. R. P. 288321, 1914; abst. C. A. 1916, **10**, 2285.
30. Ber. 1883, **16**, 2835; 1884, **17**, 499; abst. J. C. S. 1884, **46**, 590, 1185.
1. Aust. P. 11497, 1902. See D. R. P. 109737; abst. Chem. Centr. 1900, **71**, II, 231.
2. J. prakt. Chem. 1877, **123**, 165; abst. J. C. S. 1877, **32**, 337.
3. U. S. P. 1271392, 1271393, 1918. F. P. 423417. E. P. 110041, 1916; abst. C. A. 1918, **12**, 410, 983; J. S. C. I. 1917, **36**, 1185; 1918, **37**, 555-A. See also A. Vosmayer, Chem. Weekblad, 1920, **17**, 36; abst. Chem. Zentr. 1920, **91**, II, 646.
4. Ber. 1894, **27**, 3314; abst. J. C. S. 1895, **68**, i, 148.
5. U. S. P. 1039858, 1039859, 1912; abst. J. S. C. I. 1912, **31**, 1042.
- D. R. P. 237786.
6. Chem. Ztg. 1907, **31**, 143; abst. Wag. Jahr 1907, **53**, II, 553.
7. F. P. 473603, 448330. Swiss P. 64241, 1912; abst. Kunst. 1913, **3**, 217.
- Hung. P. Appl. 3460; abst. Chem. Ztg. 1913, **37**, 818.
8. U. S. P. 1107003, 1197316, 1273967. E. P. 20986, 1912.
9. Ber. 1913, **46**, 110; abst. J. S. C. I. 1913, **32**, 189.
10. U. S. P. 1061346, 1067855, 1067856, 1080188, 1126926, 1135340, 1218146.
11. Elec. World, 1911, **57**, 632; abst. C. A. 1911, **5**, 1875.
12. E. P. 11581, 1913. D. R. P. 271898, 1913; abst. C. A. 1914, **8**, 2466.
13. U. S. P. 1095058, 1914. E. P. 26182, 1912; abst. J. S. C. I. 1913, **32**, 253; 1914, **33**, 605. Farb. Ztg. 1919, **23**, 307; abst. C. A. 1919, **13**, 2138; J. S. C. I. 1920, **39**, 342-A.
14. Ber. 1893, **26**, 85; abst. J. C. S. 1892, **62**, i, 222.
15. E. P. 2682, 1906, 29907, 1910; abst. J. S. C. I. 1906, **25**, 1067; 1911, **30**, 982.
16. E. P. 11886, 1913. Commutator bars of Bakelite, Condensite or Vulcabeston.
17. D. R. P. 317267, 1918; abst. J. S. C. I. 1920, **39**, 377-A.
18. E. P. 142806, 1920.
19. Can. P. 187645, 188600, 1920.
20. D. R. P. 310783, 1918; abst. J. S. C. I. 1920, **39**, 273-A.
21. Chem. Weekblad, 1920, **17**, 2; abst. C. A. 1920, **14**, 1119.
22. U. S. P. 1326579, 1919; abst. J. S. C. I. 1920, **39**, 165-A.
23. D. R. P. 318509, 1914; abst. J. S. C. I. 1920, **39**, 445-A.
24. U. S. P. 1330444, 1920; abst. J. S. C. I. 1920, **39**, 272-A.
25. E. P. 138061, 139147, 1919; abst. C. A. 1920, **14**, 1762, 1877; Chem. Met. Eng. 1920, **23**, 35.
26. J. Ind. Eng. Chem. 1920, **12**, 549; abst. C. A. 1920, **14**, 2268.
27. U. S. P. 1327332, 1920; abst. C. A. 1920, **14**, 852.
28. Can. P. 184033, 1918; 194081, 1919. E. P. 132229; abst. C. A. 1920, **14**, 360.

The Diamond State Fibre Co.,¹ C. Moureu,² R. Mannesmann,³ M. Melamid,⁴ J. Steurer,⁵ L. Richardson,⁶ O. Ruff and P. Praetorius,⁷ M. Ragg,⁸ W. Robinson-Bjrdley, A. Weller and E. Dulcken,⁹ F. Robinson,¹⁰ L. Stange,¹¹ F. Sperr, Jr.,¹² M. Wieland,¹³ A. Wells and Ellis-Foster Co.,¹⁴ and H. Dunham.¹⁵

Celloidin and the Development of the Cellulose Nitrates in Microscopy. In those biological investigations involving the study of the minute structure of organisms, it becomes necessary to obtain the same in very thin sections as a preliminary to their microscopical examination. Unless the tissue is unusually cohesive portions of the more delicate members are likely either to fall out of the sections or become distorted during the subsequent sectioning operation, and hence valueless. Best results, therefore, are to be obtained by imbedding the specimen in a substance which thoroughly infiltrates the tissues and holds the various parts in proper relative proportions, even in the most delicate and fragile tissues.

The two substances in present use for this purpose are collodion and paraffin, the collodion method of imbedding being brought to the notice of histologists by Duval in 1879,¹⁶ although Schiefferdecker first recommended celloidin.¹⁷ The firm of E.

1. U. S. P. 1269292, 1918, abst. J. S. C. I. 1918, **37**, 709-A. See also U. S. P. 1236460, 1917, abst. J. S. C. I. 1917, **36**, 1092.
2. E. P. 141058, 1920; abst. C. A. 1920, **14**, 2270.
3. Dan. P. 24697, 1919, abst. C. A. 1920, **14**, 1227.
4. E. P. 133712, 133713, 137292, 137293, 137912, 1919, abst. C. A. 1920, **14**, 852, 1450, 1451.
5. Can. P. 193235, 1920.
6. U. S. P. 1342067; abst. C. A. 1920, **14**, 2244.
7. D. R. P. 303926, 1917; abst. J. S. C. I. 1920, **39**, 226 A.
8. Farben-Ztg. 1919, **25**, 16, 61, 105, 145, abst. Chem. Zentr. 1920, **91**, 11, 15, J. S. C. I. 1920, **39**, 273-A; C. A. 1920, **14**, 642.
9. E. P. 134563, 134564, 134565; U. S. P. 1331127, abst. C. A. 1920, **14**, 807, 1196, J. S. C. I. 1920, **29**, 14-A, 35 A.
10. E. P. 136298, 1920; abst. C. A. 1920, **14**, 1196, J. S. C. I. 1920, **39**, 164-A. Cf. E. P. 8875, 1905; 2122, 1908, 104887; abst. C. A. 1917, **11**, 2142.
11. U. S. P. 865807, 1907.
12. Can. P. 184890.
13. E. P. 137502, 1919; abst. C. A. 1920, **14**, 1268.
14. U. S. P. 1332860, 1920; abst. C. A. 1920, **14**, 1198, J. S. C. I. 1920, **39**, 340-A.
15. U. S. P. 1324649, 1919; abst. J. S. C. I. 1920, **39**, 164-A.
16. Jour. de l'Anat. 1879, **15**, 195; Zts. wiss. Mikr. 1888, **5**, 503; 1891, **8**, 254. Jour. Roy. Micr. Soc. 1879, (2), **2**, 460.
17. Arch. f. Anat. u. Phys. 1882, **1**, 190; Zts. wiss. Mikr. 1884, **1**, 225; 1888, **5**, 505. Cf. Zts. wiss. Mikr. 1884, **1**, 439, and Schallibaum, 1885, **2**, 522. Merkel, Arch. f. Mikr. Anat. 1883, **22**, 689. Gage, Med. Student,

Schering in 1877 patented a purified cellulose nitrate under the name "celloidin" and intended especially for microscopic work.¹ The "colloxylin" of J. Biezert introduced to microscopic technique in 1883,² and the "photoxylin" of Krysinski³ are similar. "Microcotton," "histocotton," "embedding cotton" and the "histoloid" of the Celluloid Co. are other names for a similar product.

The use of the cellulose nitrates in microscopy is comprized in three series of operations, i. e., preparation of the object for imbedding by gradual dehydration; the imbedding or impregnation methods; and the subsequent treatment of the thoroughly infiltrated pieces.⁴ Imbedding in celloidin is particularly appli-

1883, 14. N. Mason, Amer. Naturalist, 1880, 825. E. Mark, Amer. Nat. 1885, 19, 626; Jour. Roy. Micr. Soc. 1885, (2), 5, 908.

1. U. S. P. 299887, 1884; E. P. 4771, 1877; D. R. P. 4610, 1878; abst. Chem. Centr. 1879, 592; abst. Chem. Centr. 1872, 43, 64. See also D. R. P. 2660, 1876. Chem. Centr. 1873, 356; 1873, 541; Deut. Ind. Ztg. 1873, 206; Erfind. 1879, 6, 91; Dingl. Poly. 1879, 232, 192; 231, 94; Ber. 1879, 12, 310; Schering's Mittheil. 1873, 5; Poly. Centr. 1873, 39, 862; Deut. Industrieztg. 1873, 206; 1879, 18; Chem. Ind. 1878, 368; 1879, 85; Wag. Jahr. 1879, 420; Pharm. Handelsbl. 1878, 257; Amer. J. Pharm. 1879, 51, 151; Chem. Tech. Repert. 1873, 12, 1, 127; 1879, 18, 1232; Phot. Mag. 1891, 28, 13; see also Schulberg, Zts. wiss. Mikr. 1913, 30, 500; Aubertin, Zts. wiss. Mikr. 1898, 15, 200; Jordan, Zts. wiss. Mikr. 1898, 15, 53. Meyers, Zts. wiss. Mikr. 1903, 20, 66. Stepanow, Zts. wiss. Mikr. 1900, 17, 186; 1902, 19, 153. Borst, Zts. wiss. Mikr. 1904, 21, 238. Amat. Phot. 1891, 13, 367. Zts. wiss. Mikr. 1886, 3, 480, 1888, 5, 45, 505, 523; 1898, 15, 50; 1902, 19, 344. Phot. Mitth. 1898, 35, 214. R. Liesegang, "Photographische Chemie," 1898, 153. C. Leaper, "Materia Photographica," 1891, 141. P. Hanneke, "Celloidin-papier," 1897, 4, 14; A. Guerronnan, "Dictionnaire Synonymique," 1895, 32. G. Emmerich, "Lexicon fuer Photographie u. Reproductions Technik," 1910, 865. J. Wright, "Pathological Technique," 1915. Compare also A. Plowman, Zts. wiss. Zool. 1905, 78, 552; abst. Jour. Roy. Micr. Soc. 1905, 262.

2. Russ. Zts. Pharm. 1883, 22, 4; abst. Jahr. Chem. 1883, 1779. Examined by E. Johannason, Russ. Zts. Pharm. 1883, 22, 65. Zts. wiss. Mikr. 1900, 17, 450. For the colloxylin of Tschernischoff, see Zts. wiss. Mikr. 1902, 19, 244.

3. Virchow's Arch. f. path. Anat. u. Hist. 1887, 106, 217; The Microscope, 1888, 8, 183; Therap. Gaz. 1888, 380; Pharm. Centr. 1888, 9, 284; Zts. wiss. Mikr. 1892, 9, 47; Amer. Jour. Pharm. 1888, 225; Proc. Amer. Pharm. Assoc. 36, 239, 519; London Lancet, 1887, 1, 1253; Brit. Med. Jour. 1888, i, 555. See Zts. wiss. Mikr. 1894, 11, 348; 1896, 13, 470, 483; 1902, 19, 489; 1906, 23, 312; 1912, 29, 581. Jour. Roy. Micr. Soc. 1888, (2), 1, 834. W. Busse, Zts. wiss. Mikr. 1892, 9, 47. B. de Vecchi, Zts. wiss. Mikr. 1906, 23, 312; 1907, 24, 151; Jour. Roy. Micr. Soc. 1907, 109; Chem. Zentr. 1907, 78, 1, 190. P. Mitrophanow, Arch. Zool. Exper. 1895, 3, 617; Jour. Roy. Micr. Soc. 1896, 259. O. Rosenthal, Therap. Monats. 1888, ii, 172. W. Rosenthal, Therap. Monats. 88, No. 4; Monats. prakt. Dermat. 7, 541; Jahr. Chem. 1888, 2725. E. von Wahl, Petrograd Med. Wochschr. 1877, 4, 163. G. Behringer, Amer. Jour. Pharm. 1888, 225; Chem. Centr. 1888, 982; Jahr. Chem. 1888, 2725; Pharm. Post, 21, 345.

4. S. Apathy, J. Roy. Micr. Soc. 1890, (2), 113, 114, 164. Bellarminow,

cable to those tissues which readily fall to pieces when in the form of sections, and many and clever are the methods which have been devised.¹ The next step is the orientation or fixation of the object in a certain position preliminary to sectioning, or the

Anat. Anzeig. 1888, **3**, 650; J. Roy. Micr. Soc. 1889, (2), 151. C. Bodecker, Zts. wiss. Mikr. 1905, **22**, 190; 1908, **25**, 21; J. Roy. Micr. Soc. 1905, 764, 1908, 774. W. Bussee, Zts. wiss. Mikr. 1892-1893, **9**, 49. W. Canfield, Microscope, 1887, **7**, 99; J. Roy. Micr. Soc. 1887, (2), **7**, 680. A. Elsching, Zts. wiss. Mikr. 1893, **10**, 443; J. Roy. Micr. Soc. 1894, 404. P. Fish, J. Appl. Micr. 1899, **2**, 322; J. Roy. Micr. Soc. 1899, 448. M. Thomas, Proc. Amer. Soc. Micr. 1890, **12**, 123; J. Roy. Micr. Soc. 1891, 423. Phot. Mag. 1891, **28**, 13.

1. F. Aby, Microscope, 1891, **11**, 58; J. Roy. Micr. Soc. 1891, 424. N. Anitschow, Zts. wiss. Mikr. 1910, **2**, 67, abst. J. Roy. Micr. Soc. 1910, 787. S. Apathy, Zts. wiss. Mikr. 1889, **6**, 301; J. Roy. Micr. Soc. 1890, 253; also Zts. wiss. Mikr. 1889, **6**, 184; J. Roy. Micr. Soc. 1890, 113. Bodecker, Zts. wiss. Mikr. 1909, **26**, 206; 1911, **28**, 158. W. Busse, Zts. wiss. Mikr. 1891, **8**, 188, 462, 492, 1892, **9**, 462; Bot. Centr. 1892, **51**, 292. W. Canfield, Microscope, 1887, **7**, 99; J. Roy. Micr. Soc. 1887, 680. Dantschakoff, Zts. wiss. Mikr. 1909, **26**, 137. M. Duval, J. de Microgr. 1888, **12**, 226; J. Roy. Micr. 1888, (2), 667. A. v. Elsching, Zts. wiss. Mikr. 1893, **10**, 443; J. Roy. Micr. Soc. 1894, 404. A. Eyclesheimer, Amer. Nat. 1892, **26**, 354; J. Roy. Micr. Soc. 1892, 563. Field-Martyn, Zts. wiss. Mikr. 1894, **11**, 6 von Flechten, Zts. wiss. Mikr. 1903, **20**, 490. A. Florman, Zts. wiss. Mikr. 1889, **6**, 184; J. Roy. Micr. Soc. 1890, (2), 113; Zts. wiss. Mikr. 1889, **6**, 301. G. Freeborn, Amer. Mon. Micr. J. 1884, **5**, 127; J. Roy. Micr. Soc. 1884, (2), **4**, 822. Gage, J. Micr. and Nat. Sci. 1892, **11**, 192. Hamlyn-Harris, J. Roy. Micr. Soc. 1903, 238, 377. J. Heller, Ber. Klin. Wochenschrift, April 24, 1899, Zts. wiss. Mikr. 1899, **16**, 353. Koch, Zts. wiss. Mikr. 1893, **10**, 118. G. Karop, J. Q. Micr. Club 1894, **1**, 327; J. Roy. Micr. Soc. 1884, (2), **4**, 313, 314. Latteaux "Manuel de Technique Microscopique Ed. I," 236; II Ed. 263; see also J. Roy. Micr. Soc. 1883, (2), **3**, 734. C. Miller, Zts. wiss. Mikr. 1903, **20**, 298; J. Appl. Micr. 1903, **6**, 2253; Arch. Mikr. Anat. 1903, **62**, 367; J. Roy. Micr. Soc. 1903, 770. C. Minot, Amer. Nat. 1885, **19**, 828; J. Roy. Micr. Soc. 1886, (2), **6**, 164. F. Muller, Centr. Allgm. Pathol. and Pathol. Anat. 1903, **14**, 671; J. Roy. Micr. Soc. 1902, 769. L. Neumayer, Zts. wiss. Mikr. 1908, **25**, 38; J. Roy. Micr. Soc. 1908, 657. A. Plowman, Zts. wiss. Mikr. 1904, **21**, 388. Pokrowski, Mediz. Obosrenie, May 1900; Zts. wiss. Mikr. 1900, **17**, 331; J. Roy. Micr. Soc. 1901, 213. H. Richter, Zts. wiss. Mikr. 1913, **29**, 528; abst. Jour. Roy. Micr. Soc. 1913, 427. Rudnew, Zts. wiss. Mikr. 1907, **24**, 243 v. Schwamman, Zts. wiss. Mikr. 1897, **14**, 207. Ssobolew, Zts. wiss. Mikr. 1908, **25**, 410. E. Stepanow, Zts. wiss. Mikr. 1900, **17**, 185, 449; 1902, **19**, 152; J. Roy. Micr. Soc. 1900, 728. H. Summers, J. Roy. Micro. and Nat. Sci. 1892, **11**, 192. K. v. Tellyesniczky, Arch. Mikr. Anat. 1900, **4**, 54; Anat. Anzeig. 1904, **5**, 182; J. Roy. Micr. Soc. 1904, 723. Tschernischoff, Zts. wiss. Mikr. 1900, **17**, 449. Unna, Zts. wiss. Mikr. 1901, **18**, 32. A. Weber, Zts. wiss. Mikr. 1912, **29**, 186; abst. Jour. Roy. Micr. Soc. 1913, 108. Wintersteiner, Zts. wiss. Mikr. 1893, **10**, 310. Wolff, Zts. wiss. Mikr. 1899, **16**, 427. See also Am. Mon. Micr. J. 1886, **7**, 229; J. Micr. and Nat. Sci. 1892, **11**, 135; J. Anat. and Physiol. 1886, **20**, 307; J. Micro. Nat. Sciences. 1887, **6**, 241; J. Anat. and Physiol. Oct. 1884; J. Roy. Micr. Soc. 1887, **7**, 175; Zts. wiss. Mikr. 1885, **2**, 137; Zts. wiss. Mikr. 1886, **3**, 77, 174; 1887, **4**, 247; 1889, **6**, 164, 184, 301; 1891, **8**, 254; 1892, **9**, 49, 462; 1893, **10**, 74, 77, 235; 1893, **10**, 74, 75, 77, 118, 235, 316, 443, 474, 520; 1896, **13**, 469; 1905, **22**, 190, 415; 1909, **26**, 182; 1912, **29**, 457, 509. S. von Medvezky, E. P. 27263, 1910.

arrangement of a series of specimens in a predetermined manner in reference to each other.¹ After hardening the celloidin,² cutting,³ preferably with the microtome, clearing⁴ and mounting⁵

1. The following methods are representative: Alexander, Zts. wiss. Mikr. 1896, **13**, 10; J. Roy. Micr. Soc. 1896, 477. Apathy, Zts. wiss. Mikr. 1888, **5**, 47. Denne, J. Appl. Mikr. 1902, **3**, 888. Dantschakoff, Zts. wiss. Mikr. 1909, **26**, 184, 537. Eyclesheimer, Amer. Nat. 1892, **26**, 354; J. Roy. Micr. Soc. 1892, 503. Field-Martin, Zts. wiss. Mikr. 1894, **11**, 11; 1896, **12**, 364. Hoffmann, Zts. wiss. Mikr. 1899, **15**, 312; 1901, **17**, 443. Maximow, Zts. wiss. Mikr. 1909, **26**, 184, 537. F. Müller, Centr. Allgm. Path. u. path. Anat. 1903, **14**, 671; J. Roy. Micr. Soc. 1903, 769. Neumayer, Zts. wiss. Mikr. 1907, **24**, 142. Patten, Zts. wiss. Mikr. 1894, **11**, 13. Rubaschkin, Zts. wiss. Mikr. 1909, **26**, 183, 536. Staderini, Zts. wiss. Mikr. 1909, **26**, 534. Suzuki, Zts. wiss. Mikr. 1909, **26**, 183. C. Thurston, J. Appl. Micr. June 1900. Wilson, Zts. wiss. Mikr. 1900, **17**, 169. Woodworth, Bull. Mus. Comp. Zool. 1893, **25**, 45. "Italian Method," Zts. wiss. Mikr. 1909, **26**, 534.

2. S. Apathy, Zts. wiss. Mikr. 1888, **5**, 45; Jour. Micr. Soc. 1888, (2), 836. Kassling and Borrmann, Zts. wiss. Mikr. 1898, **15**, 433. S. Gage, Med. Student, 1883, i, 14; Jour. Roy. Micr. Soc. 1884, (2), **4**, 654. Petersen, Zts. wiss. Mikr. 1903, **20**, 302. H. Summers, J. Micr. and Nat. Sci. 1895, **14**, 106. See also Zts. wiss. Mikr. 1901, **18**, 32; 1902, **19**, 356; 1910, **27**, 235.

3. As by the methods of Anitschkow, Zts. wiss. Mikr. 1910, **27**, 67. Apathy, Zts. wiss. Mikr. 1888, **5**, 45; Mitth. Zool. Sta. Neapel, 1897, **12**, 372. R. Borrmann, Zts. wiss. Mikr. 1899, **15**, 433; J. Roy. Micr. Soc. 1899, 457. D. Cristina, Zts. wiss. Mikr. 1905, **22**, 99. Dimmer, Zts. wiss. Mikr. 1899, **16**, 44. Friedmann, Zts. wiss. Mikr. 1901, **18**, 14. Fromme, Zts. wiss. Mikr. 1890, **13**, 6. P. Hickey, J. Appl. Mic. 1900, **3**, 994. F. Hochstetter, Anat. Anzeig, 1880, 51; J. Roy. Micr. Soc. 1888, 159. Maximow, Zts. wiss. Mikr. 1910, **27**, 385. Mainer, Zts. wiss. Mikr. 1910, **27**, 385. Olt, Zts. wiss. Mikr. 1906, **23**, 324. Richter, Zts. wiss. Mikr. 1912, **29**, 528. Rubaschkin, Zts. wiss. Mikr. 1907, **24**, 429. Schaffer, Zts. wiss. Mikr. 1896, **13**, 6. Staderini, Zts. wiss. Mikr. 1893, **10**, 474. Strasser, Zts. wiss. Mikr. 1910, **27**, 342. J. Streiff, Arch. f. Mikr. Anat. u. Entwick., 1900, **56**, 940; J. Roy. Micr. Soc. 1900, 730; Zts. wiss. Mikr. 1901, **18**, 299. Tandler, Zts. wiss. Mikr. 1897, **14**, 36. v. Tellyesniczky, Zts. wiss. Mikr. 1905, **22**, 137. See also Zts. wiss. Mikr. 1885, **2**, 80; 1886, **3**, 175; 1887, **4**, 481, 482; 1892, **9**, 462; 1894, **11**, 208, 346; 1895, **12**, 159; 1908, **17**, 5; 1902, **19**, 151, 159, 333; 1903, **20**, 288.

4. Among the clearing agents used may be mentioned oils of origanum (J. van Gieson, Amer. Mon. Micr. J. 1887, **8**, 49; J. Roy. Micr. Soc. 1887, (2), **7**, 519); cedarwood (Jordan, Zts. wiss. Mikr. 1900, **17**, 191); clove (Suchannek, Zts. wiss. Mikr. 1890, **7**, 156; J. Micr. and Nat. Sciences, 1892, **11**, 192); white thyme (Minot, Zts. wiss. Mikr. 1880, **3**, 175. Fish, Proc. Amer. Micr. Soc. 1893; W. Busse, Zts. wiss. Mikr. 1892, **9**, 49. Weigert, Zts. wiss. Mikr. 1880, **3**, 480); bergamot (Eyclesheimer, Am. Nat. 1892, **26**, 354; J. Roy. Micr. Soc. 1892, 565); aniline (Van Gieson, Am. Mon. Mic. J. 1887, 49; J. Roy. Micr. Soc. 1887, 519); cajeput (Carnoy and Lebrun, La Cellule 1897, **13**, 71); anethol (Stepanow, Zts. wiss. Mikr. 1900, **17**, 187); castor oil (Strasser, Zts. wiss. Mikr. 1901; Zts. wiss. Mikr. 1902, **19**, 344; **18**, 33); phenol (Bergonzini, Lo Spallanzani, 1883, 196; J. Roy. Micr. Soc. 1885, (2), **5**, 559. C. Weigert, Zts. wiss. Mikr. 1880, **3**, 480, 481; J. Roy. Micr. 1887, (2), **7**, 519); ethereal mastic (Heider, Zts. wiss. Mikr. 1892, **8**, 509); and albumen glycerin (D. Cristina, Zts. wiss. Mikr. 1904, **22**, 99; J. Roy. Micr. Soc. 1905, 774).

5. R. Borrmann, Zts. wiss. Mikr. 1899, **15**, 433; J. Roy. Micr. Soc. 1899, 457; Centr. Bakt. and Par. 1899, **25**, 555. A. Fittinger, Arch. de Biol. 1885, **6**, 115. Gage and Meyers, Zts. wiss. Mikr. 1903, **20**, 67. Hericke, Zts. wiss. Mikr. 1904, **21**, 519. O. Jelinek, Zts. wiss. Mikr. 1894, **11**, 237;

the specimen is then ready for detailed microscopical examination.

In the "newer" celloidin method introduced by E. Meyer,¹ and improved by Bumpus,² the specimen is soaked in glycerol for 24 hours before cutting, after having been cleared with oil of thyme. Often it becomes desirable to combine the advantages which infiltration in celloidin and paraffin offer, and methods of combining both have been devised.³ In obtaining serial sections by celloidin impregnation, the albumen method,⁴ bergamot oil method⁵ or ether method⁶ is usually applied.

The collodionization of sections, or the treatment whereby

J. Roy. Micr. Soc. 1894, 753. E. Meyer, Centr. Allgm. Pathol. u. Pathol. Anat. 1903, **14**, 671; J. Roy. Micr. Soc. 1903, 769. H. Summers, Amer. Month. Micro. J. 1887, **7**, 73; Zts. wiss. Mikr. 1888, **5**, 504; see also 1887, **4**, 482, 483. E. Streeter, J. Appl. Micr. 1902, **5**, 1970; J. Roy. Micr. Soc. 1902, 715; Compt. rend. Soc. Biol. de Paris, 1902, **54**, 457. J. Streiff, Arch. Mikr. Anat. und Entwickl. 1900, **56**, 940; J. Roy. Micr. Soc. 1900, 730. See also Zts. wiss. Mikr. 1889, **6**, 152; 1894, **11**, 237; 1912, **29**, 581, 1904, **21**, 245.

1. E. Meyer, Biol. Centr. 1890, **10**, 508.

2. Bumpus, Am. Naturalist, 1892, **26**, 80; see Gage, Trans. Am. Micr. Soc. 1896, **17**, 361; Fish, Proc. Am. Micr. Soc. 1893, 179.

3. Apathy, Zts. wiss. Mikr. 1910, **27**, 391. A. Breckner, Zts. wiss. Mikr. 1908, **25**, 20, 421; J. Roy. Micr. Soc. 1908, 775. U. Dahlgren, J. Appl. Microscopy, 1898, **1**, 97; J. Roy. Micr. Soc. 1898, 480. Field-Martin, J. Micr. and Nat. Sci. 1894, **13**, 428; Amer. Nat. 1894, **28**, 720. Giacomini, Gazzetta delle Cliniche, Nov. 1885; Zts. wiss. Mikr. 1885, 531. Gough, Zts. wiss. Mikr. 1902, **19**, 209. Henking, Zts. wiss. Mikr. 1886, **3**, 478. Ide, La Cellule, 1891, **7**, 347; 1892, **8**, 114. Kultschitzky, Zts. wiss. Mikr. 1887, **4**, 48; J. Roy. Micr. Soc. 1887, (2), **7**, 845. J. Ryder, Queens. Micr. Bull. 1887, 43; J. Roy. Micr. Soc. 1888, (2), 512. C. Thurston, J. Appl. Microscopy, June 1900. See also J. Micro. and Nat. Sci. 1892, **11**, 192; Zts. wiss. Mikr. 1892, **9**, 11, 340; 1896, **13**, 437; 1900, **17**, 194; 1904, **21**, 212, 1911, **28**, 221, 222.

4. Apathy, Mitth. Zool. Stat. Neapel, 1887, **7**, 742; J. Roy. Micr. Soc. 1888, 671, 836; Zts. wiss. Mikr. 1888, **5**, 45; Mikrotechnik, p. 127. Argutinsky, Zts. wiss. Mikr. 1900, **17**, 37; Arch. Mikr. Anat. und Entwickl. 1900, **55**, 415; J. Roy. Micr. Soc. 1900, 403. G. Aubertin, Anat. Anzeig. 1897, **13**, 90; J. Roy. Micr. Soc. 1897, 174. D. Cristina, Zts. wiss. Mikr. 1904, **22**, 99; J. Roy. Micr. Soc. 1905, 774; Zts. wiss. Mikr. 1901, **25**, 32; J. Roy. Micr. Soc. 1902, 658. F. Dimmer, Zts. wiss. Mikr. 1899, **16**, 44; abst. J. Roy. Micr. Soc. 1899, 448. P. Hickey, J. Applied Micr. 1900, **3**, 994, 995; J. Roy. Micr. Soc. 1901, 213. Jordan, Zts. wiss. Mikr. 1898, **15**, 54. J. Kingsley, J. Appl. Micr. 1899, **2**, 325; J. Roy. Micr. Soc. 1899, 448. W. Rubaschkin, Anat. Anzeig. 1907, **31**, 30; J. Roy. Micr. Soc. 1907, 633. J. Tandler, Zts. wiss. Mikr. 1897, **14**, 36; J. Roy. Micr. Soc. 1897, 447; Centr. Bakt. u. Par. 1897, **21**, 901; J. Roy. Micr. Soc. 1897, 447.

5. G. Aubertin, Anat. Anzeig. 1897, **13**, 90; J. Roy. Micr. Soc. 1897, 174. Brazzola, Zts. wiss. Mikr. 1909, **26**, 534. W. Dantschakoff, Zts. wiss. Mikr. 1900, **25**, 32; J. Roy. Micr. Soc. 1908, 658. Carazzi, Zts. wiss. Mikr. 1909, **26**, 533. I. Kubo, Archiv. Mikrosk. Anat. u. Entwickl. 1907, **70**, 173; J. Roy. Micr. Soc. 1907, 496. Rubaschkin, Zts. wiss. Mikr. 1908, **25**, 33.

⁶ C. Weigert, Zts. wiss. Mikr. 1885, **2**, 490; J. Roy. Micr. Soc. 1886, 349.

6. H. Bumpus, J. Micr. and Nat. Sci. 1892, **11**, 262; Amer. Naturalist,

certain structures are strengthened with celloidin, which otherwise are so brittle by nature as to be prone to crumble and disintegrate when submitted to the usual microscopical method; preparatory to study, have been developed by Henking,¹ Rabl, Heider,³ C. Regaud⁴ and others.⁵ Celloidin plays an important part in the formation of injection masses for the penetration of blood vessels and the capillaries, the viscosity and elasticity of the nitrocellulose protecting them from injury during the injection process.⁶

Celloidin or Collodion Sacs. Although Morpurgo and Tirelli⁷ made some use of them three years previously, collodion sacs were first widely known through the researches of Metschnikoff, Roux, and Salambeni⁸ during their investigations on the spirillum of Asiatic cholera, published in 1896. Nocard and Roux⁹ in their investigations of the cause of pleuro-pneumonia

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1. Henking, Zts. wiss. Mikr. 1886, **3**, 478.

2. Rabl, Zts. wiss. Mikr. 1894, **11**, 170; see also Lendenfeld, Zts. wiss. Mikr. 1901, **18**, 18.

3. Heider, Zts. wiss. Mikr. 1892, **9**, 509. See also A. Plowman, Zts. wiss. Zool. 1905, **78**, 552; J. Roy. Micr. Soc. 1905, 262.

4. Zts. wiss. Mikr. 1904, **21**, 23; J. Roy. Micr. Soc. 1905, 589. C. Bodecker, Zts. wiss. Mikr. 1905, **22**, 190; 1908, **25**, 21; J. Roy. Micr. Soc. 1905, 764; 1908, 774.

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6. For the treatment of celloidin in orcein preparations see H. Jordan, Zts. wiss. Mikr. 1898, **15**, 53; J. Roy. Micr. Soc. 1898, 600. P. Schiefferdecker, J. Roy. Micr. Soc. 1897, 176; Zts. wiss. Mikr. 1896, **13**, 302. Cf. L. Neumayer, Zts. wiss. Mikr. 1914, **27**, 234; abst. J. Roy. Micr. Soc. 1911, 121.

7. Arch. ital. biol. 1893, **13**, 187.

8. "Toxine et Antitoxine Cholérique," Ann. de l'Inst. Pasteur, 1896, **10**, 261.

9. Ann. de l'Inst. Pasteur, 1898, **12**, 240.

in cattle, followed by Vincent,¹ Nocard,² F. Novy,³ C. Gorsline,⁴ Crendirouppoulis and Ruffer,⁵ C. Grubbs and E. Francis,⁶ Rodet and Gruechoff,⁷ Levy,⁸ Grenet and Salembeni,⁹ Herzberg,¹⁰ Steinhardt,¹¹ Maddoz,¹² K. Kellerman,¹³ E. Fouard¹⁴ and S. Bigelow,¹⁵ alone and with A. Gemberling¹⁶ are among those who have successfully utilized cellulose nitrate sacs in investigating the phenomena of dialysis either bacteriologically or for pure physico-chemical work. F. Novy¹⁷ has devised a practical method for manufacturing these sacs, which process, published by J. McRae in 1901,¹⁸ has been amplified by the methods of N. Harris,¹⁹ W. Frost,²⁰ W. Harvey,²¹ and others.²² At the present time the growth of cultures in collodion sacs in the peritoneal cavities of animals has become a common procedure in bacteriological investigations in which it is desired that the culture in its growth shall be raised to a predetermined virulence through the action of the nutrient

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2. Ann. de l'Inst. Pasteur, 1898, **12**, 564.
3. "Laboratory Work for Bacteriology," 1899, 499.
4. "On the preparation and use of Collodion Sacs," Contributions to Medical Research, 1903, 390.
5. Compt. rend. Soc. Biol. 1900, **52**, 1109; Brit. Med. J. 1900, **2**, 1305; abst. J. Roy. Micr. Soc. 1901, 98.
6. Bull. 7, Hygienic Lab. U. S. Marine Hospital Service, May 1902.
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8. J. Infect. Dis. 1905, 201-248.
9. Chem. Ztg. 1911, **35**, 452; abst. C. A. 1912, **6**, 3139.
10. Mitth. Versuch. **11**, 25.
11. J. Infect. Dis. **7**, No. 5, 675; abst. C. A. 1911, **5**, 115.
12. J. Roy. Micr. Soc. 1884, (2), **4**, 1002.
13. Centr. Bakt. Parasitenk., II Abt. **34**, 56; abst. C. A. 1912, **6**, 1759.
14. Bull. Assoc. Chim. Sucri. 1911, **28**, 756; see also C. A. 1911, **5**, 2014.
15. J. A. C. S. 1907, **29**, 1675.
16. J. A. C. S. 1907, **29**, 1576.
17. J. A. C. S. 1907, **29**, 1578.
18. J. Exper. Med. 1901, **6**, 635.
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20. Centr. f. Bakt. 1903, **34**, 733; Brit. Med. J. 1903, **2**, 313; abst. J. Roy. Micr. Soc. 1903, 776.
21. Centr. f. Bakt. 1908, **46**, 285; abst. J. Roy. Micr. Soc. 1908, 391. See also K. Kellerman, J. Appl. Micr. 1902, **5**, 2638; abst. J. Roy. Micr. Soc. 1903, 112.
22. L. Feval, U. S. P. 706541, 1902, abst. J. S. C. I. 1902, **21**, 1150; U. S. P. 759978, 1904. J. Maggi, E. P. 3770, 1890. Ver. Gelatine Gelatoidfolien & Flitterfabriken Akt., E. P. 11599, 1900. Soc. Anon. du Filtre Chamberlan Systeme Pasteur, E. P. 16270, 1911; abst. C. A. 1913, **7**, 5; J. S. C. I. 1911, **34**, 1331. Soc. Anon. Les Etablissements Poulenc Freres and P. Billon, F. P. 420319, 1909; S. Bishop, Med. Press. and Circ. Aug. 31, 1898. Muir and Ritchie, "Bacteriology," p. 66. R. Pitfield, "Compend of Bacteriology," 1913. J. Eyre, "Elements of Bacteriological Technique," 1913, p. 358.

body fluids and yet be protected from the influence of the body cells and the phagocytes. The cellulose nitrates, in contradistinction from other dialyzable bodies are unaffected by the gastric and enteric enzymes, hence the soluble bacteriological products can osmose through the celloidin membrane and thus be absorbed by the tissues while at the same time the animal fluids can pass within and serve as nutriment for the bacteria.

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solution of the former in the latter being known as collodion.¹ In

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the January following the announcement of the discovery of guncotton by Schönbein, J. Parker Maynard¹ and S. Bigelow,² both of Boston, suggested employment of the "soluble form of guncotton" for use in surgery,³ as a vehicle for medicine, and as a sticking plaster, although as G. Kahlbaum has correctly pointed out, Schönbein made use of an ether-alcohol solution in 1846 under the name of "ether glue" or "liquor constringens."⁴

Collodion was first introduced into the U. S. Pharmacopoeia in 1860, and has been official in all subsequent revisions. Nitro-cellulose is dissolved usually in a mixture of alcohol and ether,

1. Boston M. & S. Jour. 1848, **38**, 266.
2. Boston M. & S. Jour. 1848, **38**, 155, 178.
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although in more recent years, the use of acetone as a solvent has been advocated on account of the fact that acetone¹ possesses a greater dissolving power over a wider range of cellulose nitrates.² The collodions are ideal skin protectives, closely adherent, impervious to the action of air or water, and indefinitely stable. When tinted they are substantially invisible.³ Ordinary collodion is highly contractile and is therefore used to constrict the tissues or coapt the edges of a wound. This contractility may be overcome by the addition of castor oil,⁴ turpentine,⁵ balsam of fir,⁶ Venice turpentine,⁷ balsam of Peru,⁸ glycerol,⁹

1. For the "Acetone Collodions," see G. Beringer, *Amer. J. Pharm.* 1906, **78**, 470, *Year Book Pharm.* 1907, 221; G. Coull, *Proc. Amer. Pharm. Assoc.* 1907, **55**, 65. *Pharm. Notes and Comments*, E. Gaue and M. Webster, *Merck's Rept.* 1910, **19**, 228. *Proc. Amer. Pharm. Assoc.* 1900, **48**, 446. See also F. Faltynek, *E. P.* 5379, 1903. *Firm. Gebrüder Schubert*, *E. P.* 26182, 1912. W. Jack, *E. P.* 718, 1879. J. Kinsela, *E. P.* 1445, 1889. Lesage, *E. P.* 399369, 1909. C. A. 1910, **4**, 3121. A. Thamm, *E. P.* 3242, 1895. *Transparent Cellulose Products Co.*, D. R. P. 155749, 1902. O. Anselmino, *Chem. Ztg.* **35**, 19.

2. Pharmacopœial collodion is described as a somewhat opalescent (*Aust. Ph.*, *Dan. Ph.*, *Swiss Ph.*), semi-transparent (*Hung.*) mucilaginous, (*Swiss*, *Hung.*), colorless (*Aust.*, *Brit.*, *Dan.*), or light yellow (*Ger.*), of a syrupy consistence (*Aust.*, *Dan.*, *Ger.*, *Nether.*, *Norw.*, *Russ.*), and must be free from acids. It is a solution of 1 part of dimethocellulose (pyroxylin, soluble gumcotton) in 17.5 parts of ether and 6.5 parts of alcohol of a specific gravity of 0.832 (*Swiss Ph.*); 18 parts of ether and 1 part of alcohol of specific gravity of 0.832 (*Norweg. Ph.*); 18 parts of ether and 3 parts of alcohol of specific gravity 0.832 (*Dan. Ph.*) or 0.829 (*Netherl. Ph.*) or alcohol of a strength of 95% (*Russ. Ph.*); 18 parts of ether and 12 parts of absolute alcohol (*Roum. Ph.*); 21 parts of ether and 13 parts of alcohol of a specific gravity of 0.832 (*Ger. Ph.*); 26.46 parts of ether of a specific gravity of 0.838 (*Brit. Ph.*); 28.26 parts of ether of a specific gravity of 0.74 and 2.58 parts of alcohol (*Belg. Ph.*); 30 parts of ether of a specific gravity of 0.750 or 0.760 (*Ger. Ph.*); 35 parts of ether and 5 of alcohol of a specific gravity of 0.832, 48 parts of ether and 3 parts of alcohol of a specific gravity 0.80 (*Finn. Ph.*); 15 parts of ether of a specific gravity of 0.724 and 4 parts of 95% alcohol. The product is slightly inflammable, clear (*U. S. Ph.*, *Brit. Ph.*, *Dan. Ph.*, *Finn. Ph.*, *Ger. Ph.*, *Netherl. Ph.*, *Norweg. Ph.*, *Russ. Ph.*) or almost clear (*Swed. Ph.*).

3. Alkanet, annatto, dragon's blood or aniline colors (*F. Springmühl*, *Chem. Centr.* 1872, No. 32) are employed.

4. G. Beringer, *Proc. Amer. Pharm. Assoc.* 1909, **57**, 818. Drouet, *Compt. rend.* 1871, **72**, 411, *Les Mondes*, 1870, **24**, 321. J. Dunn, *Proc. Amer. Pharm. Assoc.* 1909, **57**. J. von Lorenzen, *Pharm. Ztg.* 1905, **50**, 20. *Mayne*, *New Swedenham Soc. Lexicon of Med.* 1882, **2**. F. Musgiller, *Proc. Amer. Pharm. Assoc.* 1870, **18**, 271. L. Riley, *E. P.* 8854, 1913; C. A. 1914, **8**, 3349. A. Schamelhout, *Bull. Soc. Roy. d. pharm. Brux.* 1909, **53**, 9. *Poly. Notiz.* 1855, **10**, 6. *Chem. Tech. Rep.* (Jacob.) 1866, **5**, 60. *Proc. Amer. Pharm. Assoc.* 1874, **12**, 303; 1907, **55**, 650. *Year Book of Pharmacy*, 1915, 329. *Chemist and Drug.* 1915, **86**, 260. *U. S. Ph.* (9 Decennial Rev.) 1916, 122.

5. *Zts. wiss. Mikr.* 1901, **18**, 33.

6. J. Dunn, *Proc. Amer. Pharm. Assoc.* 1909, **57**, 944; *Year Book Pharm.* 1910, 209. Lorenzen, *Pharm. Ztg.* 1905, **50**, 20; *Proc. Amer. Pharm.*

or benzoin,¹ thus forming the flexible or contractile collodions of the Pharmacopeia.² If additional astringent effect is desired, tannin³ alone or with phenol,⁴ creosote,⁵ thymol,⁶ camphor,⁷ or salol,⁸ or the salts of iron as ferric chloride⁹ may be added,⁹ until the de-

Assoc 1905, **53**, 523. W. Lyon, Proc Amer Pharm Assoc 1902, **50**, 708. Mayne, New Sydenham Soc. Lexicon of Medicine, 1882, **2**. Amer J Pharm 1883, **55**, 348.

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3. G. Beringer, Proc Amer Pharm Assoc 1906, **54**, 502. Bouchardat, Ger. Pharm. 35th Ed. 1916 (From Formulaire Magistral). W. Caldwell, Pharm. Era, 1899, 667, Proc Amer Pharm Assoc 1900, **48**, 445. Hill, Proc Amer Pharm Assoc. J. Macke, Amer J Pharm 1891, **63**, 125, Proc Amer Pharm Assoc 1891, **39**, 282. C. Mitchell, Amer J Pharm., Pharm J and Trans 1871, (3), **2**, 1047. Mayne, New Sydenham Soc. Lex. of Med 1882, **2**. C. Parvest, Year Book of Pharm 1870, 30. L'Union Med. Pharm J and Trans 1870, (3), **1**, 99. L'Union Med. Year Book Pharm 1879, 291. Richardson, Squire's Companion to Pharmacopeia, 1880, 89. Squibb's Materia Medica, 1910. Med. Times and Gaz. Dental Cosmos, June 1867; Amer J Pharm. 1867, **39**, 368. Schweitzer wochschr 1869, No. 1; Giornale di farmacia, Amer J Pharm 1869, **41**, 404. Amer J Pharm 1870, **18**, 207, Amer J Pharm 1869, Schweitzer wochschr 1869. Proc. Amer Pharm Assoc 1882, **30**, 67. Amer J Pharm 1881, **53**, 577, 1882, **54**, 425. Zts. des Oesterr. Apoth. Ver 1900, 183, Year Book of Pharmacy 1900, **37**, 209. Proc Amer Pharm Assoc 1901, **49**, 521. Dicks, Ency. Receipt and Process, 5562.

4. M. Desesquelle, Repert de Pharm. Ang. Amer. J Pharm 1889, **61**, 559. F. Sieker, Pharm. reuue, 1899, **37**, 377, Proc. Amer. Pharm Assoc 1900, **48**, 445. N. Martindale, Pharm J and Trans 1872, (3), **3**, 42. Mayne, New Sydenham Soc. Lex. of Med 1882, **2**, Pharm J Trans (2) **10**, 647. Proc Amer Pharm Assoc 1890, **38**, 391, 1892, **40**, 427, 1902, **50**, 709.

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sired hemostatic and styptic effect is attained. Other antiseptics as iodine,¹ iodo (tetraiodopyrol),² aristol,³ or iodoform,⁴ have proven useful additions in collodions intended for treatment of skin diseases. Where these are of a venereal character, paraform,⁵ ichthyol,⁶ pyrogallol,⁷ chrysarobin, oils of cade,⁸ mezeleon,⁹ and savin,¹⁰ and especially the salts of mercury as

375; Gwbl. Wurt. 1871, 383. Maille and Leclerc, *El Rev.* 1904, **44**, 133; Centr. Akk. Tech. 1904, **5**, 143. Mayne, New Sydenham Soc. Lex. Med. 1882, **2**. Dingl. Poly. **165**, 399; Wieck. Gwz. 1862, 316; Centr. 1863, 80. Austrian Zts. f. Farmacie No. 11; Poly. Centr. 1863, **29**, 70. Oest. Zts. Pharm. Amer. Drug. Circ. **7**, 161; Proc. Amer. Pharm. Assoc. 1863, **11**, 63. Wieck's Gwz. 1865, 36. Pharm. J. Trans. **5**, 587; (2), **10**, 647. Proc. Amer. Pharm. Assoc. XI (a, 21).

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the bichloride,¹ red oxide, and iodide;² zinc chloride³ or sulfo-carbolate,⁴ or combinations of lead as the iodide⁵ or lead plaster,⁶ have given excellent satisfaction, always in combination with collodion as the vehicle or excipient.⁷ As a rubifacient and vesicant, capsicum,⁷ croton oil,⁸ oil of mustard,⁹ oil of black pepper,¹⁰ and especially the Spanish fly preparations, cantharides,¹¹ canthar-

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idin,¹ and potassium cantharidate.² The modern corn cures are collodion combinations containing salicylic acid and Indian hemp,³ and are official in the various Pharmacopoeias and Formularies. Bromocoll, euresol,⁴ and iodized uric acid⁵ with collodion constitute topical applications for chilblains. The alkaloids morphine,⁶ aconitine,⁷ cocaine,⁸ and veratrine⁹ are often best applied to the skin by means of collodion, the alkaloids being first dissolved in oleic acid.¹⁰ Belladonna collodion is often used in diseases of the eye as a mydriatic.¹¹

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10. *Proc. Amer. Pharm. Assoc.* 1892, **40**, 246.

11. M. Conroy, *Chem. and Drug* 1891, 610; *Proc. Amer. Pharm. Assoc.* 1892, **40**, 427. *Pharm. J.* (3), **22**, 327; Year Book Pharm. 1892, 218. W. Maylor, *Pharm. J. Trans.* 1893, 56; *Proc. Amer. Pharm. Assoc.* 1894, **42**, 560. G. Merson, *Pharm. J.* (4), **14**, 234; Year Book Pharm. 1902, 216; *Proc. Amer. Pharm. Assoc.* 1902, **50**, 708. J. Tinford, *Pharm. J. Trans.* 1891, 384; *Amer. Pharm. Assoc.* 1892, **40**, 427. J. Umney, *Pharm. J. Trans.* 1891, 364; *Amer. Pharm. Assoc.* 1892, **40**, 426. R. Wright, *Pharm. J. Trans.* 1893, 173; *Proc. Amer. Pharm. Assoc.* 1894, **42**, 560. *Pharm. J. Trans.* 1892, **40**, 426; 1901, **49**, 521. *Pharm. J. Trans.* (2), **10**, 647.

The proprietary collodions as "New Skin,"¹¹ "Cornicide,"¹² "Crystalline," "Cotton Puro," Callosin, "Filmogen,"³ "Clobin," "Crystallin,"⁴ "Liquid Cuticle," "Surgical Skin Varnish," "Celakut," "Camphoid,"⁵ "Rusponi,"⁶ Rheumacollodin,⁷ "Frostin Balsam,"⁸ "Adhesion," "Autoplast,"⁹ "Constrictol," "Collocuto," "Collodioderm," "Collodioskin," "Cutoclodion," "Cuticoid," "Adhesaderm," "Filmoberm," "Elastoskin," "Elastin,"¹⁰ "Flexodion," "Dermin," "Protectone," "Alcolene,"¹¹ and "Fluid Skin,"¹² are commercial names applied to proprietary collodions or "liquid court plasters," similar to the Pharmacopoeial nitro-cellulose solutions.

Collodion in the Photographic Art. *Section Nine.* The historical development of the ramifications of the applications of the cellulose nitrates for photographic purposes, in the widest acceptance of the word, is embraced herein by the following

1. Trade Mark 59320, March 5, 1912
2. St. Louis Clinique, Amer. Drug and Pharm. Rec. 1893, 276. Proc. Amer. Pharm. Assoc. 1894, **42**, 714.
3. Schiff, Zts. Oest. Apoth. Ver. 1896, 686; Proc. Amer. Pharm. Assoc. 1897, **45**, 467.
4. E. Thibault, Apoth. Ztg. 1900, 61; Bull. de Pharm. du Sud Est 1899, 656.
5. W. Martindale, Pharm. J. Trans. 1892, 831; Proc. Amer. Pharm. Assoc. 1892, **40**, 426.
6. Gaz. med. d'Orient, 1905, **50**, 95.
7. Rheumacollodin is a trade name for acethammonsalicylic acid ethomethyl collodion.
8. Frostin Balsam is Tannobromine-collodion in Modern Materia Med.
9. Autoplast is a collodion like liquid used as an antiseptic protective coating for burns and wounds.
10. Elastin is a "Liquid court plaster."
11. Sutton calls Alcolene or Alcolene, simply collodion in ether.
12. J. Peck, E. P. 2425, 1913. L. Reily, E. P. 8854, 1913. F. Bergmann, D. R. P. 122190, 1900; Mon. Sci. 1902, (4), **58**, 192. P. Eyer, D. R. P. 225736, 1910; C. A. 1911, **5**, 6165. H. Lüttke, Belg. P. 167849, 1903. G. Beringer, Amer. J. Pharm. 1899, **71**, 269; Proc. Amer. Pharm. Assoc. 1899, **47**, 415. Bernbeck, West. Drug. 1887, 188; Proc. Amer. Pharm. Assoc. 1887, **35**, 60. Cornenberg, Jahr. Phot. 1893, 213. E. Durden, Pharm. J. Trans. 1861, 253; Poly. Centr. 1862, **27**, 1233. Guichard, Union Pharmaceutique, 1874. H. Huntington, Phys. and Surg. Ann. Arbor, 1886, **8**, 543. H. Luppocramer, Phot. Korr., **35**, 272, **50**, 227; Z. Chem. Kolloid, **12**, 309; C. A. 1913, **7**, 3930. Name, Riforma med. Oct. 30, 1897. Simpson, Pharm. J. Trans. **8**, 84. F. Wiggins, J. Surgery, May 1904. R. Williamson, Brit. M. J. Lond. 1896, **1**, 968. Proc. Amer. Pharm. Assoc. 1860, **8**, 435. Amer. J. Pharm. 1887, **59**, 294, 1892, **40**, 428; Chem. Drug. 1896, 425; Proc. Amer. Pharm. Assoc. 1897, **45**, 410. Brit. Med. J., Year Book Pharm. 1897, 252. Amer. Drug. 1898, 189; Proc. Amer. Pharm. Assoc. 1898, **46**, 663. Apoth. Ztg. 1899, 251; Proc. Amer. Pharm. Assoc. 1899, **47**, 415.

seventy-five separate main headings (see pp. 2796-2921):

1. *Historical* (2797-2823), wet collodion (2797-2798), **pyroxylin** (2799), constitution of pyroxylin (2800), precipitated pyroxylin (2802), papyroxylin (2802), nitroglucose (2803), keeping pyroxylin (2804), solvents (2804), iodizing (2806), iodizers (2807), additions to iodizers (2811), decomposition of collodion (2814), silver bath (2815), developer (2818), pyrogallol developer (2821), intensification (2822).

2. *Raw Materials* (2824).

3. *Collodion Plates*. Substratum (2825), preserving (2828), albumen (2829), gelatin collodion (2829), gallic acid (2832).

4. *Emulsions*. Bromide emulsions (2836), chloride emulsions (2840), bromo-chloride emulsions (2842), manufacture and preparation (2843), manipulation, development, fixation, intensification, toning (2845).

5. *Collodion Positives*. Developed emulsion and wet collodion prints (2848), alabastrine positives (2848), ferrotypes (2849), opalotype (2849), nitroglucose paper (2850), Wothlytype and uranium printing (2851), collodio-chloride (2851), positives (2852), collodio-citro phosphate (2855), bromide print-out (2856), self-toning (2856), gold toning (2856), combined toning and fixing (2857), platinum toning (2858), developing (2858), finishing (2859), enameling positives (2860), carbon positives (2862), celluloid substratum (2862), carbon prints (2863), transparencies, lantern slides (2865), enlarging positives on paper and glass (2867), transfers (2868).

6. *Orthochromatic Photography*. Dyestuffs (2869), light filters, color screens (2874).

7. *Color Photography*. Screen plates (2877), subtractive color photography (2881), Lippmann heliochrome processes, interference processes (2883), bleaching out processes (2884).

8. *Cinematography*. Moving pictures, Goodwin films (2884).

9. *General*. Stripping films (2900), halation (2902), varnishes (2903), flashlight (2904), ceramics (2905), photo-mechanical (2907), X-rays (2912), solar and astronomical (2912), spectroscopy (2912), microscopic structure of collodion and celluloid refractive index (2913), pigeon post in Franco-Prussian War (2914), photomicrography (2914), photoxylography, wood engraving (2915), hydrazines (2915), celluloid cements (2916), celluloid dishes,

measures, etc. (2016), celluloid reliefs (2017), celluloid focussing screens (2017-2021).

The chemical action of light was recognized by, cogitated over, and commented upon by the old philosophers. Successful attempts, however, to transfix a shadow may be said to date from 1802, when T. Wedgwood¹ obtained a reproduction by the agency of light on silver salts. V. de Niepce produced in 1813 photographs on asphalt by the action of light, by contact printing.² J. Daguerre experimented with phosphorescent solutions in connection with the camera obscura,³ and in 1829 entered into partnership with Niepce, who died in 1833, being six years before J. Daguerre announced his discovery of the daguerreotype process.

The use of sodium thiosulfate as a solvent of the sensitive silver salts;⁴ and the work of Fox Talbot,⁵ formed an interesting prelude to the announcement in 1851 by F. Archer⁶ of the collodion process, which at once furnished an enormous stimulus to photography. Archer's claim to priority of discovery of this process has been questioned by G. le Gray,⁷ S. Fry,⁸ J. Bing-

1. See J. Eder's *Ausführliches Handbuch der Photographie*, 1905, **1**, Part 1.

2. Fouqué "La Verité sur l'invention de la Photographie," 1807. Chevreul, "La Verité sur l'invention de la photographie, *Journal Savants*," 1873.

3. H. Colson, "Mémoires originaux des créateurs de la photographie," Paris, 1898. Blanquart-Evrard, "La Photographie, ses origines," Lille, 1870. Mentienne, "La decouverte de la Photographie en 1839," Paris, 1892. Tennant and Ward, "The Photominiature," New York, 1904. G. Brown, *Amat. Phot.* 1904, **39**, 411. "Historique et description des procédés Daguerreotype et du Diorama," Daguerre, Paris, 1839.

4. Edin. *Philos. J.* 1819, **1**, 8, 396.

5. See "The Pencil of Nature," Fox Talbot, London, 1844.

6. "The Chemist," New Ser. 1851, **2**, 257. *Compt. rend.* 1851, **24**, 725; *Dingl. Poly.* 1852, **125**, 28; *Ann.* 1853, **85**, 173, *J. prakt. Chem.* 1852, **56**, 485.

7. Not Legray. He first used "a solution of collodion wool." In his pamphlet, which appeared in June 1850, entitled, "Traité pratique de photographie sur papier et sur verre, Paris," he states on p. 42, "I discovered a treatment of collodion on glass with hydrofluoric ether, methyl ether, potassium and sodium fluorides dissolved in alcohol 40%, made sensitive with acetate of nitric silver and obtained pictures in 20 seconds in the shade." Le Gray's formula is practically impossible, because the fluorides produce no photographic image, and hydrofluoric ether was at that time but little known. Archer and Le Gray struggled for several years for priority over the discovery of the collodion treatment, and Archer's contentions (Snelling's *Photog. Jour.* 1857, p. 256; *Kreutzer, Jahrb. f. Phot.* 1857, p. 506), in which Fannie Archer (his wife) lent support (*Liverpool and Manchester Photog. Jour.* 1857, p. 121; *Revue Photog.* 1857, **2**, 207; *Kreutzer, Jahrb. f. Photog.* 1857, p. 506) are generally accepted. See H. de Molard, *Bull. Soc. Franc. Phot. Dec.* 1859; *Phot. News*, 1861, **5**, 9, 19.

8. See *Brit. J. Phot.* 1861, **8**, 70.

ham,¹ and J. Tunny.² J. Cutting³ obtained in 1854 a patent for the use of bromide with collodion, and the next year Taupenot,⁴ coated plates with iodized albumen and collodion and then sensitized, thus making a distinct advance. Three years later Fothergill⁵ suggested the use of ordinary albumen instead of the iodized solution of Taupenot for coating the collodion film—a process which obviated the second sensitizing, but it was not until 1861, when C. Russell introduced his tannin process,⁶ that a satisfactory dry plate was obtainable.

M. Gaudin,⁷ B. Sayce and W. Bolton⁸ made important progress. In 1873 H. Vogel⁹ laid the foundation for modern color photography by observing that the silver salts when treated with certain anilin colors became considerably more sensitive to the less refrangible rays of the spectrum. The collodion positives of Moitessier, and the methods of Crawford,¹⁰ Geoffray,¹¹ Corbin,¹² Marion¹³ and Sandtner¹⁴ were steps in advancement.

The first suggestion as to transparent flexible films was probably made by A. Parkes,¹⁵ while Ferrier¹⁶ used a thick film of collodion, gelatin coated. Fourtier¹⁷ seems to have been the first to try to use celluloid itself as an emulsion support, although J. Carbutt¹⁸ was the first to commercially introduce a celluloid film.

1. Compt rend 1852, **34**, 725; J. prakt Chem 1852, **56**, 485. "Photogenic Manipulation," London, 1851. Horn's Phot J 1854, **1**, 43; Dingt. Poly. 1852, **125**, 28.

2. See Brit J Phot. 1869, **16**, 597.

3. U S P 11266, 1854. In this connection see Phot Art J **6**, 348. J. Herschel, Phil Trans 1840, art 97; Phot J 1853, June 2. W. Crookes, Phot J 1853, July, Aug. Laborde, La Lumière, 1853, 29. A. Davanne and Barreswil, Brit J. Phot 1865, **12**, 618, 1866, **13**, 563.

4. Compt. rend 1855, **41**, 383; Phot J 1856, **3**, 102; Bull Soc Franc de Phot 1856, 17.

5. Phot. Archiv 1860, 183.

6. Phot. News, 1861, **5**, 135.

7. La Lumière, Aug. 20, 1863.

8. Phot News, 1865, **9**, 395; Phot Mitth **1**, 100, **2**, 61; Phot Korr. 1865, 333.

9. Ber 1873, **6**, 1305. Phot. Mitth **9**, 236.

10. Phot J. 1854. Cosmos, **5**, 603.

11. La Lumière, 1856, 53.

12. Bull. Soc. Franc. Phot. May 1858.

13. Kreutzer's Zts. f. Phot. 1863, 93.

14. D. R. P. 5977, 1879.

15. E. P. 1123, 1856.

16. E. P. 1550, 1881.

17. Bull Soc Franc Phot 1881, 74, 210.

18. Anthony's Bull 1888. Phot News, 1888, **32**, 806.

It must be remembered that it was *after* B. Pont¹ and A. Rollason² had secured patent protection for coating plates with a collodion emulsion, that F. Archer³ filed his patent. Later in the same year J. Clive⁴ and J. and D. Day⁵ received only provisional protection for their composite photographic processes. The next year J. Johnston⁶ patented the first collodion ferrotype method; C. Langlois⁷ constructed a "collodion" camera; J. Cheetham⁸ described the use of collodion in photo mechanical printing; R. Norris⁹ transferred collodion prints from glass to fabrics, while W. Newton¹⁰ communicated collodion printing methods, and T. de Beauregard¹¹ developed a chromo-gelatin process assisted by collodionized negatives.

Archer's process speedily attracted considerable attention as being far superior to daguerreotype and albumen processes, which it was destined soon to supersede. In 1851 Millet first made collodion positive pictures on enamel, which were exhibited before the French Academy of Sciences.¹² Two years later appeared the work of R. Hill Norris on the influence of the quality of pyroxylin used on the porosity and sensitiveness of the collodion dry plate. It was not until 1861 that Gaudin published his results on collodion emulsion, which, however, was not made practicable until 1864, in which year B. J. Sayce and W. B. Bolton described the usefulness of silver bromide, and established the collodio-bromide emulsion as an important branch of photographic work. W. Clark,¹³ R. Broomann,¹⁴ H. Dixon,¹⁵ T. Hooman and J. Maliszewski,¹⁶ J. La

1. E. P. 309, 1855.

2. E. P. 770, 1855.

3. E. P. 1914, 1855. In this connection see Liverpool and Manchester Phot. J. 1857, 121, Snelling's Phot. J. 1857, 256, Phot. News, 1861, **5**, 9; Art. J. 1851, July. Athenaeum 1852, Jan. Brit. J. Phot. 1869, **16**, 564, 577, 620, 1875, **22**, 4, 13, 17, 131, 156, Phot. Archiv. 1866, **27**, 209.

4. E. P. 2139, 1855.

5. E. P. 2808, 1855.

6. E. P. 2072, 1856.

7. E. P. 2254, 1856.

8. E. P. 2871, 1856.

9. E. P. 2029, 1856. See L. Angemarre, E. P. 1159, 1856.

10. E. P. 624, 1857.

11. E. P. 3066, 1858.

12. Cosmos, Mar. 1854, Dingl. Poly. 1854, **131**, 467, 1858, **147**, 157.

13. E. P. 3024, 1860.

14. E. P. 955, 1861.

15. E. P. 1074, 1861.

16. E. P. 1089, 1861.

Farge,¹ M. Risler,² A. Rollason,³ A. Worthly,⁴ L. Crozat,⁵ F. and I. Kossuth,⁶ and E. Pettit,⁷ made minor improvements. Provisional protection was granted in England to D. Reed,⁸ A. Marion⁹ and F. Grüne,¹⁰ the first two for sensitized films and the latter for photographing on ivory with collodion.

Photographic Collodions. By "collodion" is to be understood in this connection, an ether-alcohol solution of cellulose nitrate, and the idea seemed quite prevalent in the earlier days of this art, that the manufacture of pyroxylin was a proposition to which the individual experimenter should give attention, the superior results of one worker over another being attributed to some peculiar wrinkle in preparing the nitrocellulose. Therefore the early photographic journals are replete with methods and formulas for the *home* preparation of the nitrocelluloses in various weird ways, in order to supposedly impart peculiarly desirable properties to the collodion made therefrom.¹¹

F. Archer published two methods, one¹² by the use of potassium nitrate,¹³ and the other the employment of nitric acid with

1. E. P. 2598, 1862.

2. E. P. 2954, 1863.

3. E. P. 2143, 1864.

4. E. P. 2347, 1864.

5. E. P. 2953, 1864.

6. E. P. 449, 1865.

7. E. P. 72, 1865.

8. E. P. 3542, 1867. See J. Lemary, E. P. 5223, 1879.

9. E. P. 1206, 1868.

10. E. P. 2022, 1869. Cf. W. McCaw, E. P. 941, 1870.

11. Without seeming to cast aspersions on veracity, if these *investigators* actually nitrated cellulose according to their published processes, it seems little short of providential that they remained this side the Pearly Gates long enough to get their effusions into print. One "with forty years' successful experience" imparted suppleness to the collodion by adding to the cotton before nitration some glycerol; another "pioneer" preferred molasses for the same purpose, while a third got "best (?) results from the addition of a small amount of glucose. One empiricist dissolved *medicated* cotton after nitration, in a solvent composed of ether and *his private stock*, and obtained a collodion a little off-color, but "possessing extraordinary merit." No mention is made as to whether the collodions prepared from the above that decomposed, could still be salvaged as being potable. One especially meritorious collodion was obtained by treating as much as "you could get in" of "good" cotton, in a mixture of 5 gills "strong" nitric acid, and the same amount of the "best vitriol on the market," the nitration being carried on at "summer temperature," until the pyroxylin "felt right." It was then taken out and washed "until, when you chewed a little of it, you couldn't taste anything."

12. Manual of the collodion process, 1852, 14.

13. Potassium nitrate was first suggested by Millon and Gaudin, *Compt. rend.* 1846, **25**, 980, 1099. *J. prakt. Chem.* 1847, **40**, 418.

sulfuric acid for cotton nitration. A. Béchamp¹ laid stress on the importance of temperature on the reacting acids. H. Hadow,² followed by F. Hardwich,³ made a scientific study of the action of varying ratios of acids and temperatures, and upon the latter's researches, practical pyroxylin manufacture for photographic purposes may be said to be based. L. Belitzski,⁴ G. Wolfram,⁵ J. Pelouze and Maurey,⁶ Schneider and Redtenbacher,⁷ Livonius,⁸ E.

1. Compt rend 1852, **35**, 473; Dingl Poly 1852, **126**, 114. Similar methods have also been described by Livonius, N. J. Pharm **16**, 122; Magnes-Lahers, N. J. Pharm. **16**, 353; A. Martin, Guide du Photographe, 1854, 31; Mann, J. prakt. Chem 1853, **59**, 241; Mähle, N. J. Pharm **24**, 263; Souberon, J. Pharm 1848, 263; Dingl Poly 1848, **110**, 415; G. Le Gray, Horn's Phot J 1854, **1**, 8; Wengartshofer, Kreutzer's Jahr. Phot 1857, 246; Sourrisseau, Horn's Phot J 1856, **7**, 12; Gaudin, Monckhoven's Handb. Phot. 1864, 52; Delamotte, Practice of Phot. 1853, 103; Locherer, Buehler Memorial, 1868, 10; Elsner, Chem. Tech. Mitth **11**, 46; Eder, Handb. Phot. II, 180; Claudet, Horn's Phot J **3**, 60; Lugeol, Horn's Phot. J. **4**, 6; Godard, Horn's Phot J **4**, 61; Beitzki, Horn's Phot J. **2**, 62; Herling, Horn's Phot J **5**, 2; Disderi, L'Art de la Photographie 1862; Bothmann, Monats. 1880, **1**, 117; Eder's Handb. Phot. II, 181; Luchs's Dingl. Poly. 1862, **166**, 62; Jahr. Chem 1862, **15**, 467; Schnauss, Buehler, Phot. memorial, 1868, 10; Liebert, La Photographie en Amerique, 1878. See also The Silver Sunbeam, 1863, 55; Horn's Phot J 1859, **12**, 1; Phot. Zts. 1886, 277; Eder Jahr **1**, 346.

2. Phot. Jour, 1855; J. C. S. 1854, **7**, 201; Phot. News, 1861, **5**, 332. See Hardwich, Phot. Chem. 1855, 153; S. D. Humphrey, Manual of the collodion process, 1857, 46; Humphrey's Journ **6**, 12.

3. Phot. Chem. Amer. Edit. 1855, 153, Eng. first ed., 1855, 2nd, 1855, 3d, 1856; 4th, 1857; 5th, 1859, 5th, 1861, 7th, edited by Dawson and Hadow, 1864; 9th, edited by J. Taylor, 1883, Amer. Ed. same date. Practically Hadow's researches seem to have been forgotten and Hardwich is the most quoted authority in all English writings. See also Phot. News, 1861, **5**, 351, 378; J. Sellers, Humphrey's J. 1861, Phot. News, 1861, **5**, 367; Brit. J. Phot. 1862, **9**, 27; J. Nicol, Brit. J. Phot. 1861, **8**, 438; S. Davis, Brit. J. Phot. 1862, **9**, 56; Editorial, Brit. J. Phot. 1865, **12**, 53, 67; G. Dawson, Brit. J. Phot. 1869, **16**, 554; F. Banks, Brit. J. Phot. 1883, **30**, 462; J. C. Leaper's First Principles of Photography, 1892; Brit. J. Phot. 1869, **16**, 35; Towler, The Silver Sunbeam, 1863, 53; Dry Plate Photography, 1865, 35; Martin, Handb. Phot. 1857, 356; Eder's Handb. Phot. 1896, 189; Phot. News, 1865, **9**, 3; W. Ackland, Guide to Photography, Thornthwaite, 1856, 33; Beitzki, Horn's Phot. J. 1854, **2**, 62; Herling, Horn's Phot. J. 1856, **5**, 2; J. Schnauss, Buehler, Phot. Memorial, 1868, 10; Luchs, Dingl. Poly. 1862, **166**, 63; Jahr. Chem. 1862, **15**, 467; Kieffell, Handb. Phot. 1868, 105; Laport, Horn's Phot. J. 1859, **12**, 60; Mann, J. prakt. Chem 1853, **59**, 241; P. C. Duchochois, Phot. Korr. 1874, **11**, 72; Brit. J. Phot. 1873, **20**, 580, 1874, **21**, 86; Phot. News, 1874, **18**, 19; 1894, **38**, 316.

4. Horn's Phot. J. 1859, **12**, 1; Eder's Handb. Phot. 1896, **2**, 181.

5. Dingl. Poly. 1878, **230**, 245; Brit. J. Phot. 1879, **25**, 579; **26**, 30, 77, 242, 267; Phot. News, 1879, **23**, 260, 270; Poly. Notizbl. 1879, **34**, 15.

6. Compt rend 1864, **59**, 363; Chem. Centr 1865, **36**, 457.

7. Jahr. Chem. 1864, **17**, 798; Dingl Poly 1864, **174**, 209.

8. N. J. Pharm **16**, 122. For replacement of collodion in photography by nitro-saccharose, see J. Bonneville, E. P. 814, 1881.

Soubeiran,¹ L. Warnerke,² and especially J. Eder,³ made contributions to the preparation of pyroxylin especially suitable for photographic work. This considerably contributed to expansion of photography, and incidentally to the entire cellulose nitrate field.

Precipitated Pyroxylin. Considerable attention has been paid to the influence of the physical condition of pyroxylin upon the facility of solution in alcohol-ether, and the physical properties of the solutions thus produced. As near as can be gathered, the idea seemed to be to precipitate the nitrocellulose in a flocculent, spongy or porous condition so as to increase the speed of dissolution in the menstruum employed. Domonte and Menard,⁴ Homolatsch,⁵ R. Liesegang and E. Ferrer,⁶ A. Davanne,⁷ H. Vogel,⁸ having contributed methods for bringing this about.

Nitrated Paper. The papyroxyline of E. Liesegang,⁹ and the xylopaper of J. Spiller,¹⁰ was used extensively at one time for the preparation of "paper collodion"¹¹ on account of its free flowing properties. J. Pelouze,¹² W. Crookes,¹³ M. Lyte,¹⁴ J. Elliott and T. Sutton,¹⁵ E. Zettnow,¹⁶ and P. Champion,¹⁷ investigated the com-

1. J. Pharm 1848, 263, Dngl. Poly. 1848, **110**, 415
2. Phot. Archiv 1878, 37, Phot. Mitth. **14**, 301
3. Wien Akad. Ber. 1879, March. Phot. Korres. 1887, 108, 240. Brit. J. Phot. 1880, **27**, 66, 177, 185, 201, Phot. News, 1881, **25**, 147; Ber. 1880, **13**, 169, Eder's Handb. Phot. 1896, **2**, 171, 178.
4. Compt. rend. 1847, **23**, 1087, **24**, 87, 390. Eder's Handb. d. Phot. 1896, **2**, 194.
5. Kreutzer's Zts. f. Phot. 1862, **5**, 108, Phot. Archiv **3**, 99. Homolatsch called it amorphous collodion.
6. F. Fabre, Traite encycl. Phot. 1890, **2**, 54.
7. Bull. Soc. Franc. Phot. 1873, 292.
8. Phot. News, 1871, **15**, 583. G. Simpson claims priority for de la Have by sixteen years. Jahr. Chem. 1871, **24**, 1029. Amer. Chemist, (2), **1**, 332; Phot. News, 1874, **18**, 342. Brit. J. Phot. 1876, **23**, 385; 1877, **24**, 229.
9. Phot. Archiv 1866, 281. Brit. J. Phot. 1869, **16**, 78, 108, 473. Phot. News, 1869, **13**, 133. See also W. Bolton, Brit. J. Phot. 1889, **36**, 363. A. Freund, Brit. J. Phot. 1867, **14**, 481. G. Simpson, Amer. Chemist, (2), **1**, 332; abstr. Jahr. Chem. 1871, **24**, 1029; Poly. Centr. 1869, **35**, 753. Brit. J. Phot. 1877, **26**, 601.
10. Bavr. Kunst. Gewerbl. 1868, 504.
11. A. Freund, Brit. J. Phot. 1868, **15**, 450.
12. Compt. rend. 1848, **7**, 713, J. prakt. Chem. 1839, **16**, 168. See also Joh. Chem. Schriften, **5**, 39.
13. Horn's Phot. J. 1854, **1**, 86.
14. Horn's Phot. J. 1854, **2**, 78. Davanne's Annuaire, de la Phot. 1868. Brit. J. Phot. 1868, **15**, 211.
15. Phot. J. 1858. Horn's Phot. J. 1859, **11**, 3. The alcohol of T. Sutton (Horn's Phot. J. 1862, **18**, 75, 84) was a collodion containing no ether.
16. Pogg. Ann. 1871, **144**, 310. Phot. Korres. 1871, **8**, 245.
17. Bull. Soc. Franc. Phot. 1873, 205. Compt. rend. 1871, **73**, 114; Zts. Chem. 1871, 348; Bull. Soc. Chim. 1871, **16**, 301; Jahr. Chem. 1871, **25**, 800; Dngl. Poly. 1871, **202**, 374; Chem. News, 1871, **24**, 141.

parative value of nitrated paper over cotton for photographic purposes, and detailed methods for its preparation. W. Stillman,¹ J. Spiller² and especially the firm of E. Schering,³ attempted to purify the nitrocellulose by solution and evaporation or otherwise in order to increase the clearness of the ether-alcohol solutions.

Pyroxylin Gum is a rather loose expression which has found acceptance in connection with collodion technique, the term being first applied by J. Eder⁴ to the material remaining in solution when an ether-alcohol collodion is precipitated by a large bulk of water, the amount of this water-soluble material ranging from 0.5% to 2%, and is very low in nitrogen.

Nitroglucose at one time found considerable favor as a suppleness-inducing material to be added to collodion preparations. F. Hardwich found that when pyroxylin in alcohol ether solution was poured into water some substance was dissolved in the water which he assumed to be nitroglucose,⁵ and he therefore recommended the intentional addition of this material in order to obtain increased intensity of image. D. v. Monckhoven,⁶ E. Camuset,⁷ W. Bolton,⁸ de Pitteurs,⁹ C. Lea,¹⁰ M. Noton,¹¹ L. Pine,¹² J. Bonneville¹³ and others,¹⁴ investigated the applicability

1 Brit J Phot 1874, **21**, 281

2 Phot News, 1883, **27**, 453 Mot Phot 1883, **22**, 152

3 E. P. 1451, 1877, 4771, 1879, D. R. P. 2660, 1878, abst J. A. C. S. 1879, **1**, 175, 179, Dngl Poly 1879, **231**, 94, **232**, 192, Ber 1879, **12**, 310, Deut Industrieztg 1879, **18**, Chem Ind 1879, **2**, 85, Wag. Jahr 1879, **26**, 420, Chem. Tech. Rep. 1878, **17**, II, 166, 1879, **18**, I, 233, Industriebl. 1879, 94; Phot. Corr. **16**, 134

4 Sitz. Wien Akad. Wiss. 1879, **79**, 5 Eder's Handb. Phot. 1896, **2**, 195. Phot. News, 1864, **28**, 372

5. Manual of Phot. Chem. 1854, 129 Phot. J. 1856, 1857, 256, Bull. Soc. Phot. Fran. 1857, 22 Kreutzer Jahr 1856, 172, 1857, 256 Cosmos Rev. Ency. 1857, **10**, 627 Horn's Phot. J. 1857, **7**, 41, **8**, 26 Hardwich Manual, 1864, 129 Fabre Traite Ency. Phot. 1890, **2**, 55 Phot. News, 1878, **22**, 502, 1883, **27**, 261, 1884, **28**, 372 Towler, Silver Sunbeam, 1863, 63 Brit. J. Phot. 1874, **21**, 398, 1878, **25**, 477

6. Brit. J. Phot. Aug. 1, 1865

7 Bull. Soc. Franc. Phot. 1870, 37

8. Brit. J. Phot. 1874, **21**, 338, 388, 398 Gough (Brit. J. Phot. 1874, **21**, 328) suggested the addition of three or four drops glucose for every 100 g. of cotton used for nitrating

9. Brussels Sect. Belg. Phot. Assoc., 1878, abst. Brit. J. Phot. 1878, **25**, 475; Phot. News, 1878, **22**, 502

10. Amer. J. Sci. 1868, **45**, 181; abst. Phot. News, 1868, **12**, 381.

11. Phot. News, 1875, **19**, 92.

12. Humphrey J., abst. Brit. J. Phot. 1867, **14**, 28, 62. Wieck Gewer. Ztg. 1867, 79.

13. E. P. 814, 1881, abst. Chem. Ind. 1881, **4**, 139. F. P. 141285, 1881; abst. Mon. Sci. 1882, **24**, 730. Phot. News, 1878, **25**, 467.

14. Brit. J. Phot. 1878, **25**, 467, 486.

of nitroglucose in conjunction with collodion (see p. 2850). The capricious action of this body when improperly purified caused its use in this connection to be gradually abandoned, until at the present time it probably has no technical uses.

The stability of nitrocellulose has been discussed in Chapter IX, and practical methods for stabilization detailed in Chapter X. There are a few points in connection with the *keeping* of photographic pyroxylin, that may be noted at this time. F. Hardwich¹ declared that light changed pyroxylin into a gummy mass, a point to which A. Davanne took exception. G. Dawson,² W. Noverre,³ H. Vogel,⁴ and H. Wortley,⁵ independently, investigated the subject from a photographic standpoint, but their results were not in agreement. J. Eder⁶ found decomposition sets in with especial rapidity in firmly closed bottles, and far more slowly when encased in paper. The results of J. Spiller⁷ and H. Fourtier⁸ were similar. D. v. Monckhoven in 1863⁹ expressed the opinion that decomposition of collodion arises not entirely from the action of acid, as impurity in the nitrocellulose or solvents used to dissolve it, but from the slow decomposition of the pyroxylin in the presence of the alcohol, giving rise to ethyl nitrate and nitrite, and which impart to old collodion the distinctive bouquet.

The general solvents of the cellulose nitrates constitute Vol. II of this series, some of the more important of them having been touched upon earlier in this chapter (pp. 2486-2553). In photography, however, ethyl alcohol and ethyl ether, in varying proportions, are the main solvents employed for collodion formation.¹⁰ In the early days—up to about 1858—one may almost

1. Phot. J. 1860; abst. Jahr. Chem. 1860, **13**, 499; Rep. Chim. Appl. **2**, 65.
2. Brit. J. Phot. 1869, **16**, 554.
3. Phot. News, 1879, **23**, 93, 109.
4. Phot. Mitth. 1878; abst. Phot. News, 1878, **27**, 151.
5. Phot. J. 1879; abst. Phot. News, 1879, **23**, 52. See also Brit. J. Phot. 1879, **26**, 23. Gage, Phot. News, 1874, **18**, 342. C. Weber, J. S. C. I. 1893, **12**, 117; Phot. Ann. 1894, 64.
6. Phot. Korr. **16**, 216; Eder, Hand. Phot. 1896, **2**, 223.
7. Phot. News, 1883, **27**, 453.
8. Dict. Prat. Phot. 1892, **1**, 273.
9. Brit. J. Phot. 1863, **10**, 150.
10. F. Scott Archer, Manual of the Collodion Photographic Process, 1852, 17, used ether only and added about 5 drops of alcoholic solution of potassium iodide to the ounce. P. H. Delamotte, Practice of Phot. 1853, 104, advised 1 of alcohol to 24 of ether. W. Ackland, Thornthwaite's Guide to Phot. 1850, 34, used 1:3. Hardwich, Manual of Phot. Chem.; Amer.

say that an ethereal solution of pyroxylin was used, the alcoholic content being extremely low, and in most instances was added only as the solvent of the halogen salts. Such collodions high in ether were found to possess the disadvantages of too rapid drying of film, so that it was difficult to prevent the formation of wave-like marks, and they also strongly repelled aqueous solutions.¹ J. Elliott and T. Sutton² were the first to adopt the ratio 1:1, and were followed by R. Liesegang,³ L. G. Kleffel,⁴ and this has been the general practice since.⁵ It was soon found—particularly in the coating of large plates in hot weather, that it was difficult to obtain an even film with a normal collodion with an alcohol-ether ratio of 1:1, and therefore the alcohol was increased, from whence are derived the expressions *winter* and *summer* collodions.⁶ The high price in England at one time of ethyl alcohol and ether led to the advocacy of methylated ether and methylated spirits,⁷ and a fierce controversy arose as to the action of the mixtures on the resulting collodions.

The ratio of alcohol to ether was found to be of much more importance in the wet collodion than in the dry or emulsion processes, because the particular state of the film and its penetrability by the aqueous silver bath is much influenced thereby. Ether makes the collodion more fluid,⁸ while collodions high in alcohol

1. M. Gaudin, *La Lumiere*, 1854; Horn's *Phot. J.* 1854, **2**, 74, 90. Lassaigne, *Dingl. Poly.* 1848, **110**, 65. Reynaud, *Phot. Jahr* **18**, 64.

2. *Phot. J.* 1858; Horn's *Phot. J.* 1859, **11**, 3.

3. *Phot. Archiv.* 1860, **1**, 43.

4. Kleffel's *Handb. Phot.* 1868, 118.

5. T. Sutton, Schnauss' *Lexicon*, 1860, 16. *Phot. Notes*, 1862, **7**, 68, 82; *Phot. News*, 1862, **7**, 170; *Brit. Phot.* 1861, **8**, 72, 84. *Rep. encycl. Phot. de la Blanchere*, 1863, **3**, 4. J. Eder, *Handb. Phot.* 1896, **2**, 202. Towler, *Silver Sunbeam*, 1864, 81.

6. Krüger, *Die Photographie*, 1867, 387; Lemling, *Der Forscher*, 1864, 5. Towler, *Silver Sunbeam*, 1864, 81; *Phot. Archiv.* 1867, **8**, 164. D. Monckhoven, *Traite gen. f. Phot.* 1873, 207. Abney, *Instruction in Phot.* 1876. Vogel, *Phot. Mitth.* **5**, 1621. Cf. D. Monckhoven, *Handb. d. Phot.* 1864, 175.

7. Professor E. Wall, *Dict. of Phot.* 1912, 314. As to the use of methylated spirit, see Nicol, *Brit. J. Phot.* 1863, **10**, 441, 453; Traill Taylor, *Brit. J. Phot.* 1863, **10**, 328; Reynolds, *Brit. J. Phot.* 1864, **11**, 330; 1865, **12**, 400, 627; *Phot. News*, 1881, **25**, 61; Hill, *Brit. J. Phot.* 1898, **45**, 300. J. Spiller seems to have been the first to suggest the use of methylated spirit. *Phot. J.* 1855. Michaelis, *Phot. Woch.* 1896, **22**, 185. *Phot. Ann.* 1897, 177. See also *Brit. J. Phot.* 1863, **10**, 328, 441; 1864, **11**, 77, 330; 1865, **12**, 400, 627; 1891, **38**, 771, 815; 1895, **42**, 164; 1898, **45**, 300.

8. Babo, *Dingl. Poly. J.* 1865, **136**, 381. W. Blanchard, *Phot. Mitth.* **5**, 123.

appear to be more sensitive, and to give greater density.¹ Absolute alcohol and ether—rarely met with in this connection—are less suitable for collodion making than when containing a small proportion of water,² and it was not unusual to add water to the alcohol.³ J. Eder,⁴ T. Sutton,⁵ and Gardner, Mason and J. Chapman⁶ have investigated this important point thoroughly.

*Iodizing.*⁷ F. Hardwich, as early as 1855,⁸ attempted to determine whether silver bromide or iodide is the more sensitive to light. Bromized collodion is more stable and hence retains its sensitiveness for a longer period than the iodized. The controversy of the relative merits of iodide over bromide was finally adjusted by the general acknowledgment that a mixture of the two gives best results as a generality. S. Davis,⁹ J. Eder,¹⁰ M.

1. F. Hardwich, *Man Phot Chem* 121. T. Sutton, *Heinlein's Photo-graphicon*, 38; Eder, *Handb d Phot* 1896, **2**, 204.

2. F. Hardwich, *Horn's Phot. J.* 1857, **8**, 26. Mariot, *Horn's Phot. J.* 1857, **8**, 67; *Phot. Korr.* 1865, **2**, 143. Desprats, *Horn's Phot. J.* 1859, **11**, 42. Gaudin, *Phot. Archiv.* **2**, 236. T. Sutton, *Phot. News*, 1862, **7**, 170; *Phot. Archiv.* 1862, **3**, 117; Kleffel's *Lehrb. d. Phot.* 1859.

3. G. Le Gray recommended 85% alcohol. *Martin's Handb. d. Phot.* 1857, 218.

4. *Handb. d. Phot.* 1896, **2**, 206. F. Bollmann, *Handb. d. Phot.* 1862, 14. H. Vogel, *Lehrb. d. Phot.* 1879, 122. Reynaud, *Horn's Phot. J.* 1862, **18**, 64. Mazac, *Horn's Phot. J.* 1861, **16**, 30. J. Bingham, *Instruct. in Phot.* 1855. Gaudin, *Martin's Handb. d. Phot.* 1854, 194. J. Schnauss, *Phot. Archiv.* 1861, **2**, 18. Belitzki, *Phot. Archiv.* 1863, 1; *Mon. Phot.* 1863. *Rep. Encycl. Phot. de la Blanchère*, 1863, **1**, 401.

5. *Brit. J. Phot.* 1873, **20**, 301.

6. *Phot. News*, 1874, **18**, 138; *Brit. J. Phot.* 1873, **20**, 279, 1876, **23**, 601. In this connection see also A. Riche, C. Bardy and M. Berthelot, *Bull. Soc. Franc. Phot.*, abstr. *Phot. News*, 1875, **19**, 404; *Phot. News*, 1881, **25**, 61, 162; 1905, **49**, 317. *Brit. J. Phot.* 1876, **23**, 28, 601. H. de la Blanchère, *Rep. encycl. de Phot.* 1863, **3**, 128, 159, 160. *Mon. Phot.* 1896, **3**, 154. *Phot. Ann.* 1894, 64, 1897, 177. E. P. 7277, 1893. J. Lassaigue, *Dingl. Poly.* 1848, **110**, 541; *J. Chim. Med.* 1848, Oct., 541. C. Fabre, *Traité encycl. de Phot.* 1890, **2**, 56, 59. H. Fourtier, *Dict. Pratique de Chim. photographique*, 1892, 284.

7. For general data see *Brit. J. Phot.* 1862, **9**, 196, **10**, 454; 1866, **13**, 359; 1869, **16**, 491; 1893, **40**, 826. *Phot. News*, 1862, **6**, 467; 1867, **11**, 406, 1868, **12**, 265, 1872, **16**, 465; 1881, **25**, 381; 1883, **27**, 261. *Bull. Soc. Franc. Phot.* 1857, **3**, 80; 1867, **13**, 304. *Phot. Jahr* **17**, 52.

8. *Manual of Phot. Chemistry*, Amer. Edit. 1855, 142. Interesting papers on this subject will be found by Reynaud, *Bull. Soc. Franc. Phot.* 1862; *Brit. J. Phot.* 1862, **9**, 62, 196, 358, 376; *Rep. encycl. Phot. H. de la Blanchère*, 1863, **3**, 153. See Evans, *Brit. J. Phot.* 1871, **18**, 161.

9. *Phot. Jahr*, **18**, 25.

10. *Brit. J. Phot.* 1876, **23**, 121, 200, 318; 1877, **24**, 90; *Phot. News*, 1876, **20**, 267, 351. *Phot. Corresp.* 1876, **13**, 83; abstr. *Chem. Centr.* 1876, **47**, 514. *Handbuch d. Phot.* 1896, **2**, 220.

Juilhet,¹ Beer,² R. Namias,³ T. Phipson,⁴ E. Reynaud,⁵ T. Ponting,⁶ G. Simpson,⁷ A. Webb,⁸ and E. Zettnow,⁹ contributed researches along this line. The collodolith and iodicollodolith of Schippang & Wehenkel¹⁰ attained some popularity in Germany.

For half-tone pictures iodo-bromized collodions are preferred.¹¹ The ratio of bromides to iodides has remained since 1851 approximately the same (i. e., 3:5), and has been the subject of researches by C. Heisch and H. Vogel,¹² Juilhet,¹³ Meynier,¹⁴ and J. Bingham.¹⁵

Iodizer. The term "iodizer" is a misnomer, for, except in the earlier days of the art, both bromides and iodides have been used, but the term has persisted until the present day. F. Archer¹⁶ used potassium iodide, Le Gray¹⁷ and J. Bingham¹⁸ employed the corresponding ammonium salt, the latter with potassium fluoride;¹⁹ Laborde and Brebisson²⁰ found cadmium iodide most suitable.

1. Brit J Phot 1864, **11**, 105
2. Brit J Phot 1867, **14**, 401
3. Mon Phot 1903, **10**, 199
4. Phot News, 1866, **10**, 328.
5. Brit J. Phot 1862, **9**, 62
6. Brit J Phot 1862, **9**, 376
7. Phot Jahr **18**, 28
8. Brit J Phot 1862, **9**, 358 Rep encycl de Phot H de la Blanchère, 1863, **3**, 153
9. Pogg Ann Phys 1872, **145**, 185, abst Chem Centr 1872, **43**, 361; Phot Mitth 1872, **8**, 276, 295, 300, 1893, **9**, 4
10. D R P 989a, 1879, abst Jahr Chem 1880, **33**, 1310, Chem Ztg 1880, **4**, 441
11. See J. Cutting, U. S. P. 11266, 1854, (page 2798)
12. Elements of Phot 1863 Heisch, Elements of Phot 1863, 216, and Van der Beck, Phot Archiv 1864, 393, used for copying engravings, ammonium iodide with one-tenth of calcium chloride Newton (Phot. Mitth. 1875, 227) used the chloride, bromide and iodide of cadmium See also Brit J Phot 1869, **16**, 491
13. Brit. J Phot 1864, **11**, 105
14. Brit J. Phot 1866, **13**, 359
15. Phot World, abst Brit J Phot 1871, **18**, 339
16. The Chemist, 1851 Manual of the photographic process, 1852,
20. W. T. Wilkinson, Brit J Phot 1875, **22**, 260 See S. D. Humphrey's "Practical Manual of the Collodion Process," N. Y. 1857, 58 P. H. Delamotte, "Practice of Photography," 1853, 105 A. de Brebisson, "Nouvelle methode photographique sur Collodion, 1853, abst Rep encycl Phot. H. de la Blanchère, 1863, **1**, 90 Hlasiwetz, Dingl Poly, 1854, **133**, 118, Poly. Centr. 1854, **20**, 1269
17. "Photographie," 1852, 94, 1854, 94. See Kreutzer's Jahr. Phot. 1857, 135 La Lumiere, 1857, 161, Phot Jahr. 1854, **17**, 6.
18. Photogenic Manipulation, 1851: Jahr. Chem 1852, **4**, 216 Compt. rend. 1852, **34**, 725, Dingl Poly. 1852, **31**, 28, Ann 1852, **84**, 173, J. prakt. Chem. 1852, **56**, 485. Cf. Berry, Rep. encycl Phot H de la Blanchère, 1863, **1**, 332.
19. L. Montizon, Cosmos, 1854, 213
20. La Lumière, 1853, No 20 Fabre Traité encycl Phot 1890, **2**,

Belloc¹ used CdBr_2 with KI and NH_4I , and D. Monckhoven,² cadmium salts alone. H. Vogel³ preferred the bromide and iodide of cadmium mixed. It was F. Hardwich⁴ who first pointed out that cadmium salts increase⁵ the solubility of alkaline halides in collodion, without specifically recognizing the formation of a double salt.

Cadmium salts were also used by J. Elliott,⁶ Meynier,⁶ Lasimore,⁷ J. Nicol,⁸ Duchois,⁹ W. Long,¹⁰ H. de la Blanchère,¹¹ C. Waldeck,¹² Jeanrenaud,¹³ Savard,¹⁴ Seely,¹⁵ J. Schnauss,¹⁶ R. Liesegang,¹⁷ H. Wothly,¹⁸ Martin,¹⁹ Sabatier,²⁰ Thouret,²¹ Borlinetto,²² Despratz,²³ Piard,²⁴ Webb,²⁵ M. Sanders,²⁶ Weekes,²⁷ Crespon,²⁸ Inglis,²⁹ Braun,³⁰ Auxerre,³¹ N. Rood,³² Spencer,³³ Sarony,³⁴ Bordeau,³⁵

60; Eder's Handb. Phot. 1896, **2**, 215. Bull. Soc. Franc. Phot. 1857, 98; Kreutzer's Jahr, 1857, 265.

1. Traité de la photographie sur collodion, 1854. Les quatre branches de la photographie, 1855. Rep. encycl. Phot. H. de la Blanchère, 1863, **1**, 196.

2. Traité de Photographie sur collodion, 1855.

3. Brit. J. Phot. 1871, **18**, 39; Lehrbuch der Phot. 1870, 1878.

4. Manual of Phot. Chem. 1859, 243; German Edit. 1864, 125; Eder's Handb. Phot. 1896, **2**, 214.

5. Rep. encycl. Phot. H. de la Blanchère, 1863, **1**.

6. Bull. Belge. 1866, 219.

7. Phot. News, 1858, **2**, 137.

8. Phot. News, 1858, **2**, 167.

9. Phot. News, 1859, **3**, 233.

10. Dry Collodion Process, 1857, 7.

11. Rep. encycl. Phot. 1863, **3**, 338.

12. Rep. encycl. Phot. 1863, **3**, 339.

13. Rep. encycl. Phot. 1863, **3**, 101; Brit. J. Phot. 1863, **10**, 96.

14. Rep. encycl. Phot. 1863, **3**, 193.

15. Brit. J. Phot. 1861, **8**, 433; Phot. News, 1861, **5**, 612.

16. Brit. J. Phot. 1861, **8**, 286; Phot. News, 1861, **5**, 330, 391.

17. Phot. News, 1861, **5**, 58; Brit. J. Phot. 1868, **15**, 369.

18. Phot. News, 1861, **5**, 594.

19. Bull. Soc. Franc. Phot. 1861; abst. Brit. J. Phot. 1861, **8**, 254.

20. Brit. J. Phot. 1862, **9**, 198.

21. Brit. J. Phot. 1862, **9**, 474.

22. Rep. encycl. Phot. de la Blanchère, 1863, **2**, 104.

23. Rep. encycl. Phot. de la Blanchère, 1863, **1**, 204.

24. Brit. J. Phot. 1864, **10**, 30.

25. Brit. J. Phot. 1864, **10**, 64.

26. Amer. J. Phot. 1865; abst. Brit. J. Phot. 1865, **12**, 338.

27. Brit. J. Phot. 1865, **12**, 551.

28. Brit. J. Phot. 1866, **13**, 408.

29. Phila. Phot. 1866. See Fabre, Traité encycl. Phot. 1890, **2**, 67.

30. Brit. J. Phot. 1866, **13**, 610.

31. Brit. J. Phot. 1866, **13**, 500; 1868, **15**, 237.

32. Brit. J. Phot. 1866, **13**, 613.

33. Brit. J. Phot. 1866, **13**, 6. Brit. J. Phot. Annual, 1866.

34. Brit. J. Phot. 1868, **15**, 409.

35. Phil. Phot. 1868; abst. Brit. J. Phot. 1868, **15**, 506.

Waitz,¹ S. Davies,² Reutlinger,³ W. Kemp,⁴ J. Towler,⁵ D. Bachrach,⁶ Roche,⁷ Petsch,⁸ Hall,⁹ T. Sutton,¹⁰ W. Black and Anderson,¹¹ Melander,¹² Husher,¹³ Potter,¹⁴ Castellani,¹⁵ Chaffin,¹⁶ Zimmerman,¹⁷ Reichard,¹⁸ Gougenheim,¹⁹ Davanne,²⁰ Scotellari,²¹ Jewell,²² Liebert,²³ E. M. Estabrooke,²⁴ C. Klary,²⁵ Boissonas,²⁶ Spencer,²⁷ Kroh,²⁸ Gihon,²⁹ Beeles,³⁰ Bayard, Agnads, Fierlantz and Doughty,³¹ Barker,³² Wall,³³ Perrot de Chaumeux,³⁴ W. Heighway,³⁵ Eder,³⁶ Ferret,³⁷ and De la Riviere.³⁸

J. Schnauss³⁹ first used lithium salts, and Liesegang⁴⁰ employed them in conjunction with cadmium salts, but their relatively

1. Bull. Belge, 1868; abst. Brit. J. Phot. 1868, **15**, 545.
2. Brit. J. Phot. 1868, **15**, 340.
3. Brit. J. Phot. 1869, **16**, 491.
4. Brit. J. Phot. 1869, **16**, 375.
5. "Dry Processes in Phot." 1863, 51.
6. Silver Sunbeam, 1866, 67.
7. Brit. J. Phot. 1871, **18**, 161.
8. Phot. News, 1871, **15**, 536.
9. Brit. J. Phot. 1871, **18**, 39.
10. Phot. News, 1873, **17**, 482.
11. Brit. J. Phot. 1873, **20**, 301. "New Wet Collodion Process," 1873, 9.
12. Brit. J. Phot. 1873, **20**, 289, 472; Phot. News, 1873, **18**, 226, 289, 361, 362.
13. Brit. J. Phot. 1873, **20**, 315; Phot. News, 1873, **17**, 317.
14. Brit. J. Phot. 1873, **20**, 423.
15. Phot. News, 1873, **17**, 508.
16. Phot. News, 1874, **18**, 148.
17. Phot. News, 1874, **18**, 556; Brit. J. Phot. 1874, **21**, 556.
18. Phot. News, 1874, **18**, 481.
19. Brit. J. Phot. 1874, **21**, 270.
20. Bull. Belge, 1877; abst. Brit. J. Phot. 1877, **24**, 406.
21. Le Progrès de Phot. 1877, 12, 23.
22. Brit. J. Phot. 1877, **24**, 622.
23. Phot. News, 1878, **22**, 509.
24. Phot. News, 1878, **22**, 125.
25. Pract. Phot. 1878; Brit. J. Phot. 1878, **25**, 389.
26. Brit. J. Phot. 1878, **25**, 549.
27. Phot. News, 1878, **22**, 461; Phot. Mitth. 1878, 207.
28. Phot. Wochenbl. 1879; Brit. J. Phot. 1879, **26**, 584.
29. Phot. News, 1879, **23**, 603.
30. Phot. News, 1879, **23**, 298.
31. Fourtier Dict. pract. phot. 1892, 285.
32. Brit. J. Phot. 1879, **26**, 31.
33. Brit. J. Phot. 1880, **27**, 30.
34. Phot. News, 1882, **26**, 750.
35. Phot. News, 1897, **41**, 628.
36. Formules, Recettes et Tables, 1900, 29.
37. Phot. par le collodion, 1903, 4.
38. Bull. Soc. Franc. Phot. 1856. Rec. encycl. Phot. H. de la Blanchère, 1863, **2**, 23.
39. Phot. Archiv. 1860, 62.
40. Eder Handb. Phot. 1896, **2**, 216.

high price and deficient stability of the collodion led to their disuse. They have been recommended by H. Wortley,¹ for instantaneous work; Melander² used LiI with Cd and NH₄ iodides; while S. Davis³ advocated a mixture of LiBr and LiI.

L. Belitzski,⁴ W. Mayall,⁵ V. Heath and C. Heisch,⁶ Moulton,⁷ Spencer,⁸ Hall,⁹ Scotellari¹⁰ and Maxwell Lyte¹¹ used magnesium halides. Potassium fluoride¹² was found to be worthless. Ferric chloride,¹³ ferrous iodide,¹⁴ ferrous bromide,¹⁵ and ferrous bromide and iodide¹⁶ have been recommended, but not extensively used.

Of the organic iodizers, tetraethylammonium iodide,¹⁷ ethylamine iodide, bromide, or chloride,¹⁸ were placed on the market in 1873.¹⁹ Aniline bromide and iodide were found useless by J. Eder and Toth.²⁰ Migurski²¹ employed cadmium and tetraethylammonium iodides. Kingsley²² advocated arsenic bromide and iodide; J. B. Reade worked with cobalt and ammonium iodide,²³

- 1 Brit J Phot 1863, **10**, 70 Rep encycl Phot H. de la Blanchère, 1863, **3**, 101.
- 2 Phot News, 1873, **17**, 317, Brit J Phot. 1873, **20**, 315
3. Brit J Phot 1878, **25**, 339.
- 4 Horn's Phot J **10**, 31
5. Horn's Phot J **13**, 76, Rep encycl Phot de la Blanchère, 1863, **1**,
14. Fabre, Traité encycl Phot 1890, **2**, 60, Eder Handb Phot 1895, **2**, 217.
- 6 Brit J Phot. 1861, **8**, 133
7. Phot News, 1861, **5**, 612
- 8 Brit J. Phot 1868, **15**, 409
- 9 Phot News, 1873, **17**, 482
- 10 Brit J Phot 1877, **24**, 622
- 11 Rep encycl Phot de la Blanchère, 1863, **1**, 14
- 12 Eder Handb Phot 1896, **2**, 167. G. Wolfram, Phot. News, 1879, **23**, 338
- 13 Geoffray, Cosmos, 1855, 382, Dingl. Poly. 1855, **136**, 380; Poly. Centr. 1855, **21**, 945, abst Wag. Jahr. 1855, **1**, 144. Caron, Cosmos, **6**, 146; Dingl. Poly 1855, **135**, 374, Poly. Centr. 1855, **21**, 634
- 14 Neiler, Horn's Phot J 1857 Eder Handb Phot 1896, **2**, 217. Maconochie, Phot News, 1858, **2**, 30
15. D. Monckhoven, Horn's Phot J, 1858, 17.
- 16 Sahler, Rev Phot 1861; abst Phot. News, 1861, **8**, 342
- 17 L. von Babo, Pogg Ann Phys 1856, **97**, 499, Fabre, Traité encycl. Phot. 1890, **2**, 62; Eder Handb Phot 1896, **2**, 217. Pharm J. 1856; Amer. J. Pharm. 1856, **28**, 440, Rep encycl Phot de la Blanchère, 1863, **1**.
- 18 D Monckhoven, Phot. Archiv 1861, 72. Fabre, Traité encycl Phot 1890, **2**, 62. Eder Handb Phot. 1896, **2**, 217.
19. Phot. Korr. 1873, 125.
20. Phot. Korr. 1877, 9. Eder Handb. Phot. 1896, **2**, 217. Brit. J. Phot. 1877, **24**, 90.
- 21 Rep. encycl Phot de la Blanchère, 1863, **1**, 212.
- 22 Martin's Handb Phot 1857, 215. Rep. encycl. Phot. de la Blanchère, 1863, **1**. See T. Sutton, Phot. Notes, 1860, 157, Kreutzer's Zts. **3**, 10. Eder Handb. Phot 1896, **2**, 217.
- 23 Brit. J. Phot. 1868, **15**, 253.

while Laborde,¹ F. Hardwich,² and Liesegang,³ replaced potassium halides by the corresponding sodium salts. Braum⁴ used sodium and cadmium iodides; H. Vogel⁵ preferred sodium bromide with cadmium and sodium iodides; a combination also experimented with by Liesegang,⁶ Kroh,⁷ and Barker and Hart, used mixed sodium and potassium halides.

Laborde and Brebisson⁸ tested zinc bromide, and Laborde⁹ the iodide, while Le Gray¹⁰ and also Migurski¹¹ combined the two. Boissonas¹² iodized with zinc, cadmium and ammonium iodides. Berry¹³ first recommended calcium bromide, and Kohnke¹⁴ the iodide. Clarke¹⁵ suggested calcium chloride, and Black¹⁶ adopted a mixture of ammonium and cadmium iodides with CaCl_2 . Chaffin¹⁷ obtained best results with calcium bromide. Strontium iodide,¹⁸ chloride¹⁹ and bromide,²⁰ strontium iodide and ammonium bromide,²¹ have also been brought forward for the production of special effects.²²

Additions to Iodizer. Various additions to the collodion have been suggested either to make it more rapid, or to produce greater

- 1 Bull. Soc. Franc. Phot. 1857, 58
- 2 Fabre, *Traité encycl. Phot.* 1890, **2**, 61, *Eder Handb. Phot.* 1896, **2**, 215
- 3 Phot. News, 1861, **5**, 58
- 4 Brit. J. Phot. 1866, **13**, 501.
- 5 Brit. J. Phot. 1866, **13**, 120, 1868, **15**, 8, 1871, **18**, 39, 226
- 6 Brit. J. Phot. 1868, **15**, 369
- 7 Brit. J. Phot. 1879, **26**, 750
- 8 La Lumière, 1853, No. 29.
- 9 Bull. Soc. Franc. Phot. 1857, 98, *Krutzner's Jahr.* 1857, 265.
- 10 Fabre, *Traité encycl. Phot.* 1890, **2**, 61
- 11 Rep. encycl. Phot. de la Blanchère, 1863, **1**, 212
- 12 Phot. News, 1878, **22**, 546, Brit. J. Phot. 1878, **25**, 549
- 13 Horn's Phot. J. 1855, **4**, 47
- 14 Buhler's Memorial, 1868
- 15 Sci. Amer. 1866, Brit. J. Phot. 1866, **13**, 62, 1868, **15**, 340
- 16 Brit. J. Phot. 1873, **20**, 289, 456, 472, Phot. News, 1873, **17**, 289, 361
- 17 Phot. News, 1874, **18**, 556, Brit. J. Phot. 1874, **21**, 556. See also Phot. Korr. 1867, 76. Fabre, *Traité encycl. Phot.* 1890, **2**, 66. Anthony's Phot. Bull. 1895, Mon. Phot. 1895, **11**, 42
- 18 Liesegang, *Phot. Archiv.* 1869, 74.
- 19 Anthony's Phot. Bull. 1895, Mon. Phot. 1895, **11**, 42
- 20 Eder, *Phot. Korr.* 1895, 167, *Eder Handb. Phot.* 1896, **2**, 216, *Formules, Recettes et Tables.* 1900, 29.
- 21 R. Namias, *Rev. Suisse Phot.* 1903, Mon. Phot. 1903, **19**, 199.
- 22 In this connection see also Brit. J. Phot. 1868, **15**, 253, 325; Phot. News, 1863, **7**, 278. Bull. Soc. Franc. Phot. 1855, **1**, 60, 1857, **3**, 86, 98. Rep. encycl. Phot. de la Blanchère, 1863, **1**, No. 326. J. Ferret, "La Photographie par le Collodion," 1903, 4. Wilde, *Chem. Tech. Rep.* 1879, **13**, 11, 186. Mon. Phot. 1866-1867, **6**, 68, 1867-1868, **7**, 112, 1877, **16**, 47, 1879, **18**, 151, 160, 166. Fabre, *Traité encycl. Phot.* 1890, **2**, 60.

freedom from fog or increase the density. Few, however, have survived in general practice. Free iodine¹ was used to prevent formation of fog and increase the contrast; a small amount of nitric acid acting in a similar manner.² As free bromine liberates iodine, it has a similar action.³

In many instances the reason for the addition is not clear. Among the products which have been advocated in this connection may be mentioned sodium acetate,⁴ lead acetate,⁵ lead nitrite,⁶ sodium or potassium nitrite,⁷ platinum chloride,⁸ gold bromide and gold chloride,⁹ gallic acid,¹⁰ tannin,¹¹ potassium phosphite and sodium phosphite,¹² uranum nitrate,¹³ nitrogen iodide,¹⁴ urea,¹⁵ creosote,¹⁶ aldehyde,¹⁷ chloroform,¹⁸ iodoform,¹⁹ chloral hydrate,²⁰ glycerol,²¹ sugar,²² morphine acetate,²³ cod liver oil,²⁴ ben-

1. See G. Le Gray, *Photographie*, 1852. A. Belloc, *Traité de la Photographie sur collodion*, 1854. Gaudin, *Horn's Phot. J.* 1855, 54. Hardwich, *Manual Phot. Chem.* Amer. Edit. 1855, 181.
2. A. de Brebisson, *Traité complet de Photographie sur Collodion*, 1855. Cf. *Phot. Mitth.* 1869, 27.
3. Pascalis, *Girb's Phot. Jour.* **2**, 26. Barie, *Kreutzer's Jahr.* 1856, 60. Keith, *Kreutzer's Jahr.* 1857, 131. Liebert, *Phot. en Amer.* 1878, 453. H. Wilde, *Phot. Korr.* 1879, 110. Hardwich, *Manual Phot. Chem.* 1855, Amer. Edit. 73. Eder, *Phot. Korr.* 1878, 211; 1879, 132, *Handb. Phot.* 1896, **2**, 218. T. Sutton, *Brit. J. Phot.* 1860, **7**, 22; *Kreutzer's Zts.* 1860, 6. See *Phot. News*, 1859, **3**, 233, 280. *Brit. J. Phot.* 1865, **12**, 467.
4. T. Sutton and G. Dawson, *Phot. News*, 1858, **2**, 30.
5. Parr, *Phot. Archiv.* 1861, 238. *Horn's Phot. J.* 1864, **6**, 40. Heinlein's *Photographicon*, 1864, 63. Heid, *Eder Handb. Phot.* 1896, **2**, 218.
6. Laborde, *Monckhoven's Traité gen. Phot.* 1864, 169.
7. Sahler, *Hardwich Manual Phot. Chem.* 129.
8. Fabre, *Traité encycl. Phot.* 1890, **2**, 67.
9. Fabre, *Traité encycl. Phot.* 1890, **2**, 67. Barnes, *Heinlein's Photographicon*, 1864, 63.
10. *Traité gen. Phot.* 1864, 169. Bovey, *Phot. Archiv.* 1870, 92.
11. *Phot. Archiv.* 1861, 238.
12. H. Sahler, *Brit. J. Phot.* 1863, **9**, 331; *Bollmann's Phot. Monatshefte*, 1863, 101.
13. Fink, *Phot. Korr.* 1865, 186. Barker, *Phot. News*, 1882, **26**, 750.
14. *Bull. Soc. Franc. Phot.* 1873, 83. *Brit. Phot.* 1873, **20**.
15. Hase, von Babo, *Horn's Phot. J.* 1855, **3**, 15, 23; *Dingl. Poly.* 1855, **136**, 381; *Poly. Centr.* 1855, **21**, 1322; *Poly. Notizbl.* 1855, **10**, 241; *Pharm. J.* 1856; *Amer. J. Pharm.* 1856, **28**, 440.
16. F. Archer, *Kreutzer's Jahr. Phot.* 1855, 18.
17. Conduché stated that this increased sensitiveness, but Babo denied this and Monckhoven said that it had no effect. See *Traité gen. Phot.* 1865, 219.
18. R. Shadbolt, *Phot. J.* 1855, 56. Patrick, *Kreutzer's Jahr.* 1857, **261**. Mayall, *Rep. encycl. Phot. de la Blanchère*, 1863, 1.
19. W. Hockin, 1852. See F. Hardwich, *Kreutzer's Jahr.* 1857, 253.
20. R. Liesegang, *Brit. J. Phot.* 1870, **17**. *Phot. Archiv.* 1870, 93.
21. See *Kreutzer's Jahr.* 1850, 64. R. Shadbolt, *Dingl. Poly.* 1854, **133**, 433; **136**, 56; *Chem. Centr.* 1855, **26**, 49, 174. M. Gaudin, *Phot. News*, 1861,

zine, helenin and oil of turpentine,¹ anilin,² camphor,³ soap,⁴ silver oleate,⁵ phenol,⁶ glycyrrhizin,⁷ oil of cloves,⁸ ammoniacal resin,⁹ alcoholic solutions of wax or paraffin,¹⁰ rubber,¹¹ copaiba balsam,¹² gelatin or isinglass,¹³ ammonium acetate,¹⁴ benzoin,¹⁵ iodine cyanide,¹⁶ uranium salts,¹⁷ coumarin and coumarin bromine compounds,¹⁸ mercury,¹⁹ albumen,²⁰ mercuric cyanide,²¹ paraffin²²

5, 319, 364. Rep. encycl. Phot. de la Blanchère, 1863, **2**, 45. Dixon, Phot. News, 1874, **18**, 58. Phot. Jahr **17**, 34. Bull. Soc. Franc. Phot. 1876, **22**, 95.

22. Bull. Assoc. Belge, 1875, **1**, 255. Mon. Phot. 1875, Jan. Brit. J. Phot. 1867, **14**, 67.

23. Bartholomew used the acetate. Diamond used morphine acetate. See Monckhoven, Traité gen. Phot. 1865, 219. Phot. Archiv 1867, 233.

24. Barnes, Phot. J. 1860, 214. Hallenbeck, Phot. Mitth. 1872, **8**, 188.

1. All three increase the stability of the collodion. Hallenbeck, Phot. Mitth. 1872, **8**, 188. Helenin is the camphor obtained from Inula Helenium, see Merck's Index, 2nd edic. 1902, 120.

2. K. Schwieler, Eder's Handb. Phot. 1896, **2**, 219. Fabre, Traité encycl. Phot. 1900, **2**, 67.

3. J. Cutting, U. S. P. 11213, 1854; E. P. 1638, 1854. Humphrey's Manual of the collodion process, 1857, 178. Dingl. Poly. 1855, **136**, 206. Poly. Centr. 1855, **21**, 242. Heinelein's Photographicon, 1864, 65. Liebert's Phot. en Amer. 1878, Prumm, Phot. Mitth. **10**, 102.

4. Simpson, Phot. Mitth. 1867, **3**, 210.

5. R. Courtenay, Eder Handb. Phot. 1896, **2**, 219. Phot. News, 1866, **10**, 422.

6. Kaiser, Bull. Belg. 1867, 16. Voyle, Phot. Archiv 1868, 279.

7. F. Hardwich, Kreutzer's Jahr. 1857, 103. Silver Sunbeam, 1863, 63.

8. Hadow, 1854. Hardwich's Manual Phot. Chem. Kreutzer's Jahr. 1857, 103, 251.

9. Resin boiled in ammonia. Hardwich, Eder Handb. Phot. 1896, **2**, 219.

10. Halpen, La Lumière, 1854, Jan. Lespiault, La Lumière, 1854, July. Horn's Phot. J. 1860, 215. Warnerke, Brit. J. Phot. 1875, **22**, 369.

11. Fry, Athenaeum, 1851, Dec. 27. Kreutzer's Jahr. 1851, 89. Brebisson, Nouvelle méthode sur collodion, 1852. M. Sanders, Amer. J. Phot.; abstr. Brit. J. Phot., 1865, **12**, 358. Sanders, Amer. J. Phot.; abstr. Brit. J. Phot. 1865, **12**, 358.

12. Böttger, Phot. News, 1873, **18**, 360.

13. Kroh, Phot. Woch. 1879; Brit. J. Phot. 1879, **26**, 584.

14. Jeanrenaud, Mon. Phot. 1863; Brit. J. Phot. 1863, **10**, 85, 96; Rep. encycl. Phot. de la Blanchère, 1863, **3**, 101.

15. It has been stated that the addition of about 1% of gum benzoin to collodion will cause the picture to develop itself after exposure, the plate remaining sensitive, after the silver bath, for only one-half hour.

16. Geoffray, Wag. Jahr. 1855, **1**, 44. Cosmos, 1855, 382; Dingl. Poly. 1855, **136**, 380; Poly. Centr. 1855, **21**, 945.

17. G. Markham, Brit. J. Phot. 1872, **19**, 266. H. Wortley, Phot. News, 1875, **19**, 246.

18. Anon. Brit. J. Phot. 1870, **17**, 552.

19. Phot. News, 1859, **3**, 12, 228.

20. V. Griswold, U. S. P. 15336, 1856. See Humphrey's Manual of Collodion Process, 1857, 186.

21. Geoffray, Cosmos, 1855, 382; Dingl. Poly. 1855, **136**, 380; Poly. Centr. 1855, **21**, 945; Wag. Jahr. 1855, **1**, 144. See also H. Davy, Gerhardt, Lehrb. organ. Chem. 1854, **1**, 517.

22. L. Warnerke, Brit. J. Phot. 1875, **22**, 369.

are among the materials proposed for this purpose.¹

Decomposition of Collodion. The early workers soon discovered that iodized collodion does not keep, and, although colorless when freshly prepared, soon darkens until red, with a corresponding diminution in sensitiveness. F. Hardwich,² Testelin,³ J. Eder,⁴ T. Sutton and G. Dawson,⁵ and others,⁶ advanced theories, but the decomposition depends upon a number of obscure factors, which, in their entirety, have not as yet been satisfactorily explained.

Various means for restoring or decolorizing old collodion have been brought forward, as by the addition of potassium cyanide,⁷ ammonia,⁸ sodium carbonate,⁹ sodium bicarbonate,¹⁰

1. See also M. Ferrier, *Bull. Soc. Franc. Phot.* 1874, **20**, 91. M. Franck de Villecholle, *Bull. Soc. Franc. Phot.* 1874, **20**, 90. Gage, *Bull. Soc. Franc. Phot.* 1859, **5**, 287. T. Gulliver, *Phot. News*, 1867, **11**, 270. M. Gaudin, *Brit. J. Phot.* 1861, **8**, 287, *Phot. News*, 1862, **6**, 197; 1863, **7**, 500, 520. C. Heisch, *Phot. News*, 1863, **7**, 340; *Bull. Soc. Franc. Phot.* 1862, **8**, 239. C. Waldack, *Amer. J. Phot.*, abstr. *Phot. News*, 1863, **7**, 160. W. Scott, *Bull. Soc. Franc. Phot.* 1860, **6**, 44. Waitz, *Bull. Soc. Franc. Phot.* 1868, **14**, 271. G. Simpson, *Bull. Soc. Franc. Phot.* 1862, **8**, 157. Anon., *Brit. J. Phot.* 1867, **14**, 95, 311; 1868, **15**, 515; 1869, **16**, 225; 1873, **20**, 204, 1892, **39**, 154; 1896, **43**, 473, *Phot. Woch.* 1895, 358. *Phot. News*, 1859, **2**, 121; 1862, **6**, 157, 229, 302, 478, 503, 505; 1863, **7**, 10, 116, 131, 217; 1866, **10**, 75, 134, 398, 547, 1876, **20**, 465. *Brit. J. Phot.* 1872, **19**, 405. *Rep. encycl. Phot. de la Blanchère*, 1863, **3**, 27, 45. *Bull. Soc. Franc. Phot.* 1857, **3**, 80; 1858, **4**, 276. Fabre, *Traité encycl. Phot.* 1890, **2**, 67. *Pharm. J.* 1856, June; abstr. *Amer. J. Pharm.* 1856, **28**, 440. F. Wilde, *Phot. Corr.* 1878, **15**, 212. *Phot. Jahr* **14**, 43.

2. *Manual Phot. Chem.* 1855, Amer. Edit. 72. Fabre, *Traité encycl. Phot.* 1890, **2**, 70.

3. *Rep. encycl. Phot.* 1863, **3**, 118, 150. Gaudin, *Brit. J. Phot.* 1866, **13**, 459.

4. *Handb. Phot.* 1896, **2**, 223.

5. *Dict. of Phot.* 1857, 62.

6. J. Kruger, *Brit. J. Phot.* 1871, **18**, 505. W. Abney, *Phot. News*, 1879, **23**, 38. J. Clemons, *Phila. Phot.*, abstr. *Phot. News*, 1865, **9**, 415. M. Cocco, *Brit. J. Phot.* 1867, **14**, 156, 281. E. Kruger, *Phot. News*, 1872, **16**, 151. A. Meeze, *Brit. J. Phot.* 1870, **17**, 381. E. Pepper, *Phot. News*, 1859, **3**, 275. Vogel, *Phot. News*, 1878, **22**, 381. Murray, *Ann. Gen. Civ.* 1878, 323. H. Farr, *Wilson's Phot. Mosaics*, 1879, 47. W. Klausner, *Wilson's Phot. Mosaics*, 1872, 63. R. Robinson, *Phot. News*, 1875, **19**, 125. J. Rutherford, *Brit. J. Phot.* 1873, **20**, 100. A. Testelin, *Phot. News*, 1862, **6**, 219, 305, 331; *Rep. encycl. Phot. de la Blanchère*, 1863, **3**, 118, 150. See also *Brit. J. Phot.* 1866, **13**, 459; 1867, **14**, 119, 1896, **16**, 179. *Phot. Times*, 1891, **21**, 21, 264. *Mon. Phot.* 1867-1868, **7**, 147. Fabre, *Traité encycl. Phot.* 1890, **2**, 70. *Wick's Gewerbeztg.* 1867, 32.

7. Halleur, *Kunst der Photographie*, 1853; Lindner, *Phot. Mitth.* 1870, **29**; and others, recommended the addition of a small amount of powdered potassium cyanide and thorough shaking.

8. Horn's *Phot. J.* 1854, **1**, 5, 38, 40.

9. Spiller, *Phot. Archiv.* 1864, 61.

10. Liesegang, *Phot. Archiv.* 1864, 97. Celis, *Phot. Mitth.* **7**, 29.

cocoanut soap,¹ ammonium-cadmium iodide,² morphine;³ however, the preferable remedies in addition to cyanide, appear to be metallic cadmium,⁴ and less satisfactory, silver,⁵ mercury,⁶ and calomel.⁷ The hydroxides of ammonium,⁸ potassium⁹ and calcium,¹⁰ while they neutralize the acidity and increase the rapidity of the appearance of the image, usually induce fog.¹¹

Silver Bath. The collodion film as coated on glass, contains an alkaline halide, which in itself is not sensitive to light, the sensitizing being induced by immersion in a solution of silver nitrate. Being insoluble in water and formed *in situ*, the silver halide remains as an extremely fine suspension, thus forming the light-sensitive salt.¹² An important factor in this connection is the solubility of silver halide in silver nitrate, and this has been carefully investigated by J. Schmaus,¹³ C. Weltzien¹⁴ and by C. Stürenberg.¹⁵ The normal strength of a silver bath is usually 7%-12%, although variations from the above have been recommended by F. Archer,¹⁶ C. Fabre,¹⁷ and J. Eder.¹⁸

1. Weyner, *Phot. Mitth.* **3**, 244.
2. Sentek, *Phot. Archiv.* 1865, 148.
3. M. Cocco, *Phot. Archiv.* 1867, 19.
4. M. Lyte, *Horn's Phot. J.* 1855, 6. Also proposed by Gaudin, Hardwich, H. W. Vogel, and M. Carey Lea. *Phot. Archiv.* 1865, 335.
5. Lyte. See *Phot. Archiv.* 1867, 19.
6. Crookes, *Poly. Centr.* 1855, **21**, 174, *Cosmos*, **5**, 347.
7. F. Hardwich, *Manual Phot. Chem.* 1863.
8. Clemens, *Phila. Phot.*, *Phot. Archives*, 1867, 335.
9. G. Le Gray, 1852. Laborde, *Horn's Phot. J.* 1852, **2**, 55. Also proposed by Belloc, Montizon and others.
10. *Phot. Archiv.* 1860, 166. Piard, *Phot. Archiv.* 1864, 84.
11. Le Grice, Vicker, *Phot. Archiv.* 1860, 26, 60, 83.
12. As to the relative sensitiveness of silver iodide precipitated under various conditions consult Luppo-Cramer, A. Lottermoser and Rothe, *Phot. Korr.* 1908, 275. Eder, *Phot. Chem. F. Jaeger, Zts. Krystall* 1907, 169, *abst. Chem. Zentr.* 1908, **79**, I, 444. Regarding the spectral sensitiveness of wet and dry collodion plates, see W. Crookes, *Phot. J.* 1853, **1**, 98; *Pogg. Ann.* 1856, **97**, 616. J. Muller, *Pogg. Ann.* 1856, **97**, 135. W. Eisenlohr, *Pogg. Ann.* 1856, **99**, 159. G. Becquerel, *La Lumière*, 1868, **2**, 86. C. Schultz-Sellack, *Ber.* 1871, **4**, 210. H. Vogel, *Pogg. Ann.* 1874, **153**, 223. D. Monckhoven, *Traité gen. Phot.* 1880, 21. J. Eder, *Wien Akad. Ber.* 1901, **110**, 1115, *Handb. Phot.* 1912, **1**, III, 277. E. Lehmann, *Zts. physik. Chem.* 1908, **64**, 89.
13. *Arch. Pharm. (2)*, **82**, 260, *abst. Chem. Centr.* 1855, **26**, 514; *Jahr. Chem.* 1855, **8**, 419.
14. *Ann.* 1855, **95**, 127; *abst. Jahr. Chem.* 1855, **8**, 419.
15. *Arch. Pharm. (2)*, **143**, 12, *abst. Chem. Centr.* 1870, **41**, 516; *Jahr. Chem.* 1870, **23**, 377.
16. *Manual of the Collodion Photographic Process*, 1852, 28.
17. *Traité encycl. Phot.* 1890, **2**, 77.
18. *Handb. Phot.* 1896, **2**, 233. See also A. Payne, "Wet Collodion Process," 52. E. W. Foxlee, *Brit. J. Phot.* 1907, **54**, 537.

Of the silver salts, the nitrate is practically the only one used, although the lactate,¹ chlorate,² perchlorate,³ fluoride,⁴ ammonio-nitrate,⁵ and acetate⁶ have been proposed from time to time. The next ingredient in the bath is potassium iodide,⁷ to which a small amount of acid as nitric,⁸ acetic⁹ or boric,¹⁰ or elemental iodine¹¹ is often added, the latter to prevent the formation of fog.

One of the more frequent troubles with the wet collodion process is the occurrence of "pin holes"—innumerable minute semi-transparent spots over the film. J. Eder,¹² J. Spiller,¹³ F. York,¹⁴ H. Wortley,¹⁵ and G. Dawson¹⁶ have investigated this phase of the subject. Notwithstanding the suggestion of C. Fabre¹⁷ and others,¹⁸ distilled water should always be employed in making up the solutions. Gallic acid¹⁹ or uranium nitrate²⁰ may assist in increasing the density of the image. Barium nitrate in the hands

1. See Brit. J. Phot. 1873, **20**, 204; in a brief editorial it is stated that this was first suggested by M. Come de Cosio "rather more than twenty years ago," although the author has been unable to trace this. See also M. Gaudin, La Lumière, 1863, 69.

2. M. Gaudin, La Lumière, 1853, 181. G. Wolfram, Phot. Mitth. 1879, **16**, 20.

3. G. Wolfram, Phot. Mitth. 1879, **16**, 29.

4. M. Gaudin, La Lumière, 1853, 161. G. Wolfram, Phot. Mitth. 1879, **16**, 20.

5. R. Liesegang, Phot. Archiv. 1864, 457.

6. F. Hardwich, Manual Phot. Chem. 1864, 167.

7. P. C. Duchochois, Phot. Times, 1894; Phot. News, 1894, **33**, 323. Foxlee, Brit. J. Phot. 1907, **54**, 536.

8. C. Fabre, Traite encycl. Phot. 1890, **2**, 77. Eder, Handb. Phot. 1896, **2**, 233. Brit. J. Phot. 1864, **11**, 229. Black, Brit. J. Phot. 1871, **18**, 337.

9. F. Hardwich, Man. Phot. Chem. Amer. Edir. 1855, 173. Bull. Soc. Franc. Phot. 1875, 59. Phot. Archiv. 1875, 83.

10. Bull. Belg. 1867, 17. Voyle, Fabre, Traite encycl. Phot. 1890, **2**, 79.

11. Bull. Soc. Franc. Phot. 1861, 154. Phot. News, 1861, **5**, 308, 371.

12. Handb. Phot. 1896, **2**, 234.

13. Brit. J. Phot. 1877, **24**, 16.

14. Brit. J. Phot. 1877, **24**, 16.

15. Brit. J. Phot. 1877, **24**, 224.

16. Brit. J. Phot. 1865, **12**, 161, 173, 185. See also Tully, Brit. J. Phot. 1865, **12**, 95.

17. Traite encycl. Phot. 1890, **2**, 78. W. T. Wilkinson, Phot. News, 1903, **47**, 406.

18. Gatehouse, Phot. News, 1875, **13**, 423. Russell, Brit. J. Phot. 1877, **24**, 224. T. Sutton and G. Dawson, Dict. of Phot. 1858, 1st Ed. and 2nd Ed. 1867, 314; German Ed. 1864, 328. Belitzski, Phot. Mitth. 1880, **17**, 222.

19. Berry, Chevalier's Handb. Phot. 1857, 19; Cosmos, **5**, 459.

20. Phot. News, 1875, **20**, 246. J. Werge, Phot. News, 1875, **20**, 261. H. Wortley, Brit. J. Phot. 1877, **24**, 224.

of H. Vogel¹ and of A. L. Henderson² increases the sensitiveness.

Many other additions to the bath have been proposed from time to time to impart special effects, as in the formula of Girod,³ while deliquescent salts like the nitrates of zinc,⁴ magnesium,⁵ nickel,⁶ and non-drying substances as sugar,⁷ gelatin,⁸ glycerol,⁹ honey,¹⁰ oxymel¹¹ or infusion of linseed¹² are indicative of the materials proposed and used in this connection. W. de W. Abney suggested a double bath.¹³

Restoration of Old Baths. Inasmuch as in the ordinary wet plate process considerable quantities of the bath were used repeatedly, it is quite natural that attempts to restore the bath to its original condition or to recover the silver therefrom, should be made.¹⁴ Organic impurities are removable by means of potassium cyanide,¹⁵ or by sodium carbonate or bicarbonate. J. Spiller¹⁶ suggested sodium chloride or potassium citrate,¹⁷ H. Vogel, potassium permanganate,¹⁸ with subsequent exposure to sunlight for some time, and Feierabendt¹⁹ points out that there is a tendency toward the formation of acetaldehyde from reduction of the ethyl alcohol, although Krone²⁰ claims permanganate

1. Phot. News, 1865; 1877, **22**, 230.
2. Brit. J. Phot. 1873, **20**, 292; Phot. News, 1873, **17**, 290, 294, Phot. Archiv. 1873, 127. See also Waldeck, Phot. News, 1879, **24**, 16. Chisholm, Phot. News, 1874, **18**, 6.
3. Horn's Phot. J. **1**, 113. La Lumière, 1853.
4. J. Spiller and W. Crookes, Horn's Phot. J. 1854, **1**, 203, Dingl. Poly. 1856, **140**, 342, Poly. Centr. 1856, **22**, 1073.
5. "S. R. P.," Brit. J. Phot. 1866, **13**, 261. Horn's Phot. J. 1856, **2**, 6.
6. Kreutzer's Jahr. 1856, 66.
7. M. Gaudin, La Lumière, 1854.
8. A. Liébert, La Phot. en Amérique, 1878, 187.
9. Pollack, 1856; Horn's Phot. J. 1856, **2**, 309; Kreutzer's Jahr. 1856, 65.
10. J. Spiller and W. Crookes, Horn's Phot. J. 1856, **3**, 44. Gaudin, Phot. News, 1861, **8**, 319, 364. W. Harrison, Brit. J. Phot. 1865, **12**, 217; 1866, **13**, 567.
11. G. Shadbolt, Horn's Phot. J. 1854, **2**, 4. Brit. J. Phot. 1860, **13**, 567.
12. Llewelyn, Horn's Phot. J. 1855, **3**, 24. Kreutzer's Jahr. 1856, 67, Poly. Centr. 1856, **22**, 1148.
13. de Villechole, Bull. Soc. Franc. Phot. 1856, 311, Kreutzer's Jahr. 1856, 67.
14. Bull. Assoc. Belg. 1880, 340.
15. A. Vogel, Phot. Korr. 1872, 96; Eder Handb. Phot. 1896, **2**, 240.
16. Tulley, 1861. See T. Sutton, Brit. J. Phot. 1865, **12**, 95. See also Phot. News, 1877, **18**, 165. Borland, Year Book Phot. 1877, 146.
17. Phot. News, 1877, **18**, 147.
18. Eder Handb. Phot. 1896, **2**, 241. Barber, Brit. J. Phot. 1861, **8**, 159.
19. H. Vogel, Lehrb. Phot. 1878, 318. See Johnson, Brown, Tulley, Werge, Brit. J. Phot. 1868, **15**, 84.
20. Phot. Mitth. 1873, **10**, 14; Phot. News, 1873, **18**, 349.
21. Helios, 1871. Phot. News, 1871, **15**, 570. Krone also recommended

is not always effective. In estimating the strength of the bath, the methods of Cramb,¹ Leake,² and M. Gaudin³ are illustrative.⁴

*Developer.*⁵ For the development of wet plates an iron developer has been the favorite, with modifications adapted to the idiosyncrasies of individual workers. F. Archer⁶ preferred pyrogallol; G. Le Gray ferrous sulfate;⁷ Meynier⁸ proposed iron ammonium sulfate; and J. Eder and Toth⁹ recommended the corresponding double sodium salt. Although at first much used, these that the silver bath be frozen, the impurities being retained by the ice when the solution was partly thawed

¹ Brit J Phot **8**, 62

² Phot News, 1861, **5**, 565

³ La Lumière, 1864 Brit J Phot 1864, **11**, 117 See also Brit. J. Phot 1898, **45**, 20

⁴ In this connection see Cooper, Mon Phot 1864-1865, **4**, 174 M Gaudin, Phot News, 1861, **5**, 421 W Harrison, Brit J Phot 1868, **15**, 49 J Kay, Phot News, 1877, **21**, 77 E Smith, Phot News, 1861, **5**, 227 J. Spiller, Phot News, 1877, **21**, 230 Bull Soc Franc Phot 1865, **15**, 221 G. Simpson, Phot News, 1860, **3**, 233 E Anderson, Phot News, 1873, **17**, 362 McLachlan, Brit J. Phot 1868, **15**, 180, 239, 1869, **16**, 52 Anon., Brit J Phot 1862, **9**, 181, 1864, **11**, 231, 1868, **15**, 354, 619, 1874, **21**, 120; 1894, **41**, 2, 98, 114 Phot News, 1860, **3**, 276, 1861, **5**, 371, 419, 1873, **18**, 553, 1879, **23**, 8 C Fabre, Traité encycl Phot 1890, **2**, 77, 81, 84, 86, 88 Rep. encycl Phot H. de la Blanchère, 1863, **1**, 66, 84, 85, **2**, 348 Mon Phot 1865 1866, **5**, 28 Dingl Poly 1867, **185**, 408; Poly Centr 1867, **33**, 1368 J Ferret, "La Photographie par le Collodion," 1903, 20

⁵ For general information on the subject of developers for collodion plates, consult J Sanders, Phot News, 1867, **11**, 471 W Brooks, Phot News, 1876, **20**, 181 C Petersen, Phot News, 1877, **21**, 67 N Cherrill, Phot News, 1865, **9**, 522 A Harman, Phot News, 1862, **6**, 310 M Haack, Phot Corr, abst Phot News, 1867, **11**, 528 J Black, Brit J Phot 1871, **18**, 337 J Spiller, Phot News, 1876, **20**, 323 D Winstanley, Phot News, 1875, **19**, 248 Fuerst Brothers, Brit J Phot 1894, **41**, 702 A Davanne, "Le Progres de la Photographie," 1877, 17 T Leahy, Brit J Phot 1864, **11**, 535; 1866, **13**, 44 M Lea, Brit J Phot 1866, **13**, 173 J Harmer, Brit J Phot 1876, **23**, 214 H Wortley, Brit J Phot 1873, **20**, 38 C Sellers, Humphrey's J., abst Phot News, 1861, **5**, 326 W Howard, Phot News, 1877, **21**, 388 G Fennemore, Phot News, 1869, **13**, 345 Bottone, Bull Soc. Franc Phot. 1883, **29**, 89 Davanne, Bull Soc Franc Phot 1876, **22**, 93 Anon., Brit J Phot 1867, **14**, 97, 446, 1869, **16**, 455, 1873, **20**, 225, 1875, **22**, 202, 1876, **23**, 135, 1878, **25**, 191, 1880, **27**, 512, 1894, **41**, 18 J Phot News, 1861, **5**, 576, 1878, **22**, 318, 1882, **26**, 433, 1885, **29**, 177 Eder, Jahrb Phot 1888, **2**, 115, 1903, **17**, 518, 1904, **18**, 479

⁶ Chemist, 1850, May Manual of the collodion phot process, 1852, 32; La Lumière, 1851, 115

⁷ Photographie, 1852, 104

⁸ Bull Soc Franc Phot 1863, **13**, Phot Archiv 1863, 105; Poly Notizbl. 1863, **18**, 240. See also Rotier and Waldack, Bull. Belg 1874, 133 Adam-Solomon, Phila Phot 1868, abst Brit. J. Phot. 1868, **15**, 506; Rep encycl Phot de la Blanchère, 1863, **3**, 128 Musgrave, Brit J Phot 1865, **12**, 571 Thomson, Brit J. Phot 1866, **13**, 472 Warner, Brit J. Phot 1868, **15**, 291

⁹ Phot Korrr 1876, 147 Eder Handb Phot 1896, **2**, 253. Fabre Traité encycl Phot 1890, **2**, 96 Duchochois, Phot News, 1894, **38**, 323

salts gradually fell into general disuse. Of the other iron salts tried, Godard used a mixture of iron sulfate and acetate,¹ M. Gaudin,² F. Hardwich,³ Kruger,⁴ Rotier and Waldack⁵ and Eder,⁶ employed ferrous acetate. F. Hardwich⁷ combined ferrous sulfate and lead acetate, thereby producing ferrous acetate, while A. L. Henderson⁸ recommended lead acetate alone. Iron nitrate,⁹ either alone or in combination with KNO_3 ,¹⁰ or iron lactate in the hands of De la Haye,¹¹ was used to a considerable extent.

Copper salts were also frequently employed, J. Hughes,¹² Baratti,¹³ Brun,¹⁴ Elwel¹⁵ and MacNicol,¹⁶ preferring copper sulfate, and it was claimed sufficient density was thus obtained in development to obviate intensification. Practically, it has only survived for the production of line drawings.¹⁷ Boissonas¹⁸ used cupric acetate. Zinc sulfate was proposed by Warner.¹⁹ Alum,²⁰ magnesium sulfate,²¹ sodium sulfate,²² uranium sulfate,²³ the latter in

1. A. B. C. de la Photographie, 1854, 22. Fabre, *Traité encycl. Phot.* 1890, **2**, 95.

2. Horn's *Phot. J.* 1854, **2**, 82.

3. *Manual Phot.* 1859, German Ed. 1863, 9th Ed. 1883, 214.

4. *Universal Lehrbuch der Phot.* 1861, 365.

5. *Bull. Belg.* 1874, **2**, 93, *Phot. Archiv* 1875.

6. *Handb. Phot.* 1896, **2**, 254.

7. *Phot. News*, 1858, **1**, 78. *Frv. Rep. encycl. Phot. de la Blanchère*, 1863, **1**, 18. Metheson, *Brit. J. Phot.* 1861, **8**, 433. See also Phila. *Phot.* 1879, *abst. Phot. News*, 1879, **23**, 208. Scotellari, *Brit. J. Phot.* 1877, **24**, 622. V. Angerer, *Brit. J. Phot.* 1865, **12**, 315.

8. Eder *Handb. Phot.* 1896, **2**, 254.

9. R. Hunt, *Researches on Light*, 1854, 2nd Edit. 143. *Cosmos*, 1852, **1**, 25.

10. J. Spiller, Horn's *Phot. J.* 1853, *Phot. News*, 1876, **21**, 283, 322, 323, 335, 1877, **21**, 51. Waldack, *Rep. encycl. Phot. de la Blanchère*, 1863, **3**, 213. Mariot, *Phot. Korr.* 1864, 62. Gaudin, *Rep. encycl. Phot. de la Blanchère*, 1863, **3**, 9.

11. *Bull. Soc. Franc. Phot.* 1858, 176.

12. *Phot. Archiv* 1878, 169.

13. *Bull. Soc. Franc. Phot.* 1867, 135.

14. *Bull. Soc. Franc. Phot.* 1869, 319.

15. Horn's *Phot. J.* 1873.

16. *Phot. News*, 1864, **9**, 480. Also Adam Solomon, Phila. *Phot.* 1868; *Brit. J. Phot.* 1868, **15**, 506. Gohon and Chute, *Phot. News*, 1873, **18**, 182. Eich, *Phot. Archiv* 1872, 111.

17. The Militär-Geographisches Institut of Vienna was the first to introduce this for reproduction work. See Eder *Handb. Phot.* 1896, **2**, 257.

18. *Phot. News*, 1878, **22**, 546.

19. *Brit. J. Phot.* 1868, **15**, 201. See Gulliver, *Year Book Phot.* 1874, 79, *Phot. Mitth.* 1874, 12, *Phot. Archiv* 1879, 20.

20. *Phot. News*, 1879, **24**, 187.

21. *Bull. Belg.* 1866, 270. Wells, *Phot. News*, 1873, **18**, 364. Scotellari, *Brit. J. Phot.* 1877, **24**, 622.

22. *Phot. News*, 1879, **23**, 208.

23. Monckhoven, *Mon. Phot.* 1861, *Brit. J. Phot.* 1861, **18**, 217. Humphrey's *J.* 1861, **97**. Wood, *Rep. encycl. Phot. de la Blanchère*, 1863, **3**, 158.

acid solution,¹ was tried and with fairly successful results. H. Wortley² and Duchochois³ combined uranium and iron sulfates.

The use of viscous substances as sugar, glycerol and gelatin, admittedly kept the developer much clearer for a longer time,⁴ and C. Lea⁵ suggested dissolving gelatin in water, then adding sulfuric acid and iron filings. N. Cherill⁶ acidulated with acetic acid after neutralizing with ammonia, while S. D. Towler,⁷ "Clericus,"⁸ brought forward modifications of this process. Later, C. Lea⁹ used what he termed collocine, prepared by dissolving gelatin in dilute sulfuric acid and boiling with granulated zinc, this being added to the iron developer. A so-called *glycocol* developer was made by boiling gelatin with KOH solution, the solution being acidified before use.¹⁰ Glycerol,¹¹ albumen,¹² sugar,¹³ honey,¹⁴ nitrogelatin,¹⁵ nitroglycerol,¹⁶ phenol,¹⁷ morphine acetate,¹⁸ and ethyl

1. Fabre, *Traité encycl. Phot.* 1890, **2**, 99.
2. *Brit. J. Phot.* 1877, **24**, 224.
3. *Phot. News*, 1878, **22**, 263.
4. Their action has always been ascribed to the greater viscosity of the developer, Eder, *Hand. Phot.* 1896, **2**, 257; Fabre, *Traité encycl. Phot.* 1890, **2**, 99; but the effects obtained can be more satisfactorily explained by the now well recognized principle of "protective colloids." In this connection see M. Faraday, *Phil. Trans.* 1857, **147**, 154. F. v. Meyer and A. Lottermoser, *J. prakt. Chem.* 1897, **56**, 241. A. Lottermoser, *Anorg. Kolloide*, 1901, 50. R. Zsigmondy, *Zts. anal. Chem.* 1901, **40**, 697. W. Taylor, *Chemistry of Colloids*, 1915. E. Hatschek, *Physics and Chemistry of Colloids*, 1913. R. Zsigmondy, *Zur Erkenntniss der Kolloide*, 1905. Muller, *Allgemeine Chemie der Kolloide*, 1907.
5. *Brit. J. Phot.* 1865, **12**, 286. *Phot. Archiv.* 1865, 258. Silver Sunbeam, 1869, 425; Humphrey's *J.* 1865; *Bull. Soc. Franc. Phot.* 1865, 329; 1866, 125. M. Lyte suggested "metagelatine," *Horn's Phot. J.* 1857, **3**, 223, 287; *Kreutzer's Jahr.* 1857, 185. Pollitt, *Brit. J. Phot.* 1874, **21**, 135.
6. *Phot. Archiv.* 1865, 332. Collings, *Brit. J. Phot.* 1866, **13**, 68.
7. Humphrey's *J.* 1866. *Bull. Soc. Franc. Phot.* 1866, 10; Silver Sunbeam, 1869, 426. Belbeze, *Bull. Soc. Franc. Phot.* 1868, 146.
8. *Brit. J. Phot.* 1865, **12**, 581. J. Hughes, *Phot. Archiv.* 1865, 332, 387. Szekeley, *Phot. Korr.* 1865, **3**, 8. Dubost, *Phot. Archiv.* 1873; *Phot. News*, 1873, **17**, 65. P. Jennings, *Brit. J. Phot.* 1865, **12**, 612.
9. *Phot. News*, 1876; *Phot. Archiv.* 1876, 78; *Bull. Soc. Franc. Phot.* 1876, 145.
10. Bienert, *Phot. Archiv.* 1866, 393. J. Bardwell, *Phot. Archiv.* 1870, 240.
11. Hughes, *Yearbook Phot.* 1872. *Phot. Archiv.* 1872, 8. Kusel, *Bull. Soc. Franc. Phot.* 1866, 265.
12. Fitzgibbon, Humphrey's *J.* 1866; *Phot. Archiv.* 1866, 214. Dunmore, *Brit. J. Phot.* 1874; *Phot. Korr.* 1874, 232. Haddock, *Bull. Belg.* 1866, 303.
13. *Law, Phot. News*, 1864; *Phot. Mitth.* 1864, **1**, 77. Towler, *Phot. Archiv.* 1864, 498. C. Lea, *Manual of Phot.* 1869. *Phot. Archiv.* 1870, 226. G. Simpson, *Brit. J. Phot.* 1864, **11**, 58. Kaiser, *Kreutzer's Zts.* **4**, 166, used lactose. Harrison, *Phot. Archiv.* 1866, 364.
14. Shadbolt, *Phot. News*, 1865.
15. Towler, *Phot. Archiv.* 1867, 264, 268.
16. S. Bottone, *Eder Handb. Phot.* 1896, **2**, 258.

nitrite¹ and other materials² were proposed, the precise value of which is not clear.

Sulfuric acid was at first used, but it was soon recognized that an organic acid gave better results. G. Le Gray³ added acetic acid to sulfuric acid, while Bertsch⁴ followed by M. Gaudin,⁵ used acetic acid alone. Citric acid⁶ gave good results and preserved the developing solution for some weeks.⁷ Renet⁸ used tartaric acid alone, while Hudson⁹ combined it with nitric acid. Formic acid was used by Sisson,¹⁰ H. Wortley,¹¹ Cooper and Godinus,¹² and Ferrier,¹³ while succinic acid was suggested by J. Schnauss.¹⁴ Boric,¹⁵ oxalic,¹⁶ salicylic,¹⁷ and gallic acids,¹⁸ all had their advocates, but according to Barker,¹⁹ ferrous sulfate solution saturated with nitric oxide is especially excellent for positives.

Pyrogallol Developer. F. Archer,²⁰ recommended pyrogallol (pyrogallic acid, technically called *pyro*) with acetic acid, but J. Bingham²¹ maintained that nitric acid gave a whiter deposit.

17. Kaiser, Phot. Archiv. 1807, 65.
18. De Roth stated that morphine acetate alone was a developer, Phot. Archiv. 1867, 233. Krüger, Phot. Archiv. 1872, 190.
1. Martin, Bull. Soc. Franc. Phot. 1866, 265. Angerer used ether, Brit. J. Phot. 1865, **12**, 315.
2. Eder Handb. Phot. 1896, **2**, 258.
3. Photographie, 1852, 104.
4. Photographie sur verre, 1852, 19. Godard, A. B. C. de la Phot. 1854, 22.
5. Horn's Phot. J. 1854, **2**, 81. Schnauss, Phot. Archiv. 1862, 157, Phot. News, 1873, **12**, 347.
6. Bull. Soc. Franc. Phot. 1863, 128.
7. H. Krone, Phot. Archiv. 1872, 112; Kreutzer's Zts. 1863, **7**, 91.
8. Bull. Belg. 1863, 107; Horn's Phot. J. 1863, **20**, 10, 23.
9. Horn's Phot. J. 1853, **1**, 139.
10. Horn's Phot. J. 1853, **1**, 151.
11. Phot. News, 1861, **5**, 396. Kreutzer's Zts. 1861, **4**, 156.
12. Phot. Archiv. 1863, 172.
13. Bull. Soc. Franc. Phot. 1861, 114; Phot. News, 1861, **5**, 364. Remele, Phot. Mitth. 1865, 260. Schnauss, Phot. Archiv. 1862, 72. Monckhoven, Kreutzer's Zts. 1864, **7**, 81.
14. Phot. Archiv. 1866, 20; 1867, 177.
15. Mackinlay, Horn's Phot. J. 1853, **1**, 114; 1854, **2**, 99.
16. Kroh, Phot. Woch. 1879. Brit. J. Phot. 1879, **26**, 584.
17. Eder stated that a mixture of this with ferrous sulfate, dampened with sulfurous acid was sold as "rapid developing salt."
18. Tunny, Brit. J. Phot. 1861. Liesegang, Phot. Archiv. 1861, **43**, 67, 91. Rep. encycl. Phot. de la Blanchère, 1863, **3**, 11. H. Wortley, Phot. News, 1870.
19. Horn's Phot. J. 1864, **2**, 26.
20. Hardwich's Man. Phot. Chem. Amer. Ed. 1855, 88.
21. Technologiste, 1852, 583.

C. Gaillard¹ proposed the use of citric acid, Gaillard and Davanne² tried acetic, citric, malic, succinic, tartaric, benzoic, camphoric, gallic, formic, boric, tannic and perchloric acids with varying effects. Maxwell Lyte³ and R. L. Maddox⁴ found phosphoric could be used instead of citric acid. Claudet⁵ and Monckhoven⁶ were diametrically opposite as to the value of formic acid which at one time was much used in England. Lassimore⁷ adhered to the use of gallic acid, V. Heath⁸ used equal quantities of gallic acid and pyrogallol, especially for landscape work. Laborde preferred tartaric acid⁹ on account of its freedom from fog, as well as aluminium nitrate and acefate.¹⁰

Other Developers. Lorenz¹¹ tried cupric sulfate, and Wagner, pyrocatechin.¹² Lassimore¹³ proposed the use of tannin and lead acetate. M. Lea¹⁴ and Tabersky¹⁵ suggested hematoxylin, while Maxwell Lyte tried glucic acid.¹⁶ L. Babo¹⁷ reported upon the merits of aldehyde, alloxantin and phosphorous acid, but none have come into general use.

*Intensification.*¹⁸ If through an error in exposure a negative shows all details but is thin and flat, or in making negatives such as diagrams, the groundwork of the drawing is not sufficiently

1. Bull Soc Franc Phot 1855, 39
2. Bull Soc Franc Phot 1855, 93, Phot J 1854, **2**, 217, Eder Handb. Phot 1896, **2**, 259. Fabre, Traité encycl Phot 1890, **2**, 102
3. Bull Soc Franc Phot 1856, 198
4. Bull Soc Franc Phot 1856, **2**, 198, Brit J Phot 1861, **8**, 125, 336
5. Compt rend 1862, **55**, 375, Fabre, Traité encycl Phot 1890, **2**, 102
6. Bull Soc Phot Belge 1863, 159
7. Phot News 1858, **1**, 137
8. Brit J Phot 1861, **8**, 124
9. La Lumière 1853, Handbuch 1896, **2**, 260
10. Bull Soc Franc Phot 1863, **9**, 67, Phot Archiv 1863, **4**, 260
11. Brit J Phot 1871, **17**, 157, 167, 177, 179, Handbuch 1896, **2**, 260
12. Fabre, Traité encycl Phot 1890, **2**, 105
13. Rev Phot 1857
14. Brit J Phot 1861, **8**, 336
15. Bull Soc Franc Phot 1869, 301
16. Brit J Phot 1855, **2**, 255
17. Pharm J 1856, Amer J Pharm 1856, **28**, 440
18. For general data on intensification, consult Brit J. Phot. 1865, **12**, 171; 1879, **26**, 576. Photo Times, 1890, **20**, 12. Jahr Phot 1893, **7**, 403. T. Barrett, Phot News, 1859, **1**, 275. H. Draper, Phot News, 1859, **2**, 171. J. Eder and V. Toth, Phot News, 1876, **20**, 573, 579. C. Fabre, Traité encycl Phot 1890, **2**, 91, 110, 114, 115, 336, 344. M. Frey, Brit. J. Phot. 1899, **46**, 501. Franz, Brit J Phot 1881, **28**, 335. A. Kelly, Phot News, 1897, **41**, 247. K. Klauser, Phot Archiv **22**, 128, Chem Ztg 1881, **5**, 691; Chem Tech Rep. 1881, **20**, II, 119. Kron, Phot Archiv. **12**, 123; abst. Chem Tech Rep 1871, **10**, 111. W. Lang, Phot News, 1889, **33**, 410. E. Lacan, Brit J Phot 1864, **11**, 250. A. Rollason, E. P. 770, 1855. E. Wilson, Phot Archiv. **12**, 64; abst Chem Tech. Rep 1871, **10**, I, 113. W. Woodbury, Bull. Soc. Franc Phot. 1867, **23**, 230.

black, recourse is then had to intensification, which is building up the image by means of metallic silver or other metal. Intensification may be made before or after fixation. F. Archer¹ employed either an iron salt or pyrogallol. The disadvantages of the iron intensifier² are that unless citric or tartaric acids are used, the solution becomes cloudy very quickly. The pyrogallol solution is prepared on the same lines as the iron,³ it being inadvisable to push intensification too far. A. v. Hubl in 1890⁴ suggested acidulated hydroquinone, and later recommended metol.⁵ Bertsch⁶ used gallic acid because it gave a somewhat finer precipitate, while Barreswil⁷ and A. Davanne⁷ employed a mixture of pyrogallol and gallic acid.

With intensification after fixation by means of nascent silver,⁸ the plate must be well washed and blackened either by immersion in sodium thiosulfate solution, ammonia,⁹ hydrogen sulfide,¹⁰ ammonium sulfide,¹¹ potassium cyanide,¹² potassium iodide,¹³ or KI with ammonia,¹⁴ murexide¹⁵ or barium hydroxide.¹⁶

Many methods for intensification have been suggested, but few have retained their place in actual practice. W. L. Blanchard¹⁷ used mercuric chloride, carrying the action until the initial blackening and not the white stage was reached. Jourdain¹⁸ treated with potassium polysulfide (sulfurated potash, liver of sulfur), then

- 1 La Lumiere, 1851, 114. Montizon, Phot. J. 1853, **1**, 24.
- 2 Fabre, Traité encycl. Phot. 1890, **2**, 106. H. Vogel, Lehrbuch, Phot. 1878, 287.
- 3 Eder Handb. Phot. 1896, **2**, 362.
- 4 Eder Jahrb. 1890, **4**, 221, Handb. Phot. 1896, **2**, 263, Phot. News, 1890, **34**, 3.
- 5 Phot. Korn. 1892, 291, Eder Jahrb. 1893, **7**, 425, Eder Handb. 1896, **2**, 264.
- 6 Photographie sur Verre, 1852, 21.
- 7 Chime Photographique, 1891, 191.
- 8 Barreswil and Davanne, Hand. Phot. 1854, 90. Towler, Silver Sunbeams, 1864, 117, Phot. Archiv. 1864, 198.
- 9 Lespault, Horn's Phot. J. 1854, **1**, 91.
- 10 Donny, Horn's Phot. J. 1854, **1**, 186.
- 11 Roberts, Horn's Phot. J. 1854, **2**, 55. Ewing, Brit. J. Phot. 1863, **10**, 71.
- 12 Eder's Handb. Phot. 1896, **2**, 268.
- 13 M. Lyte, Horn's Phot. J. 1853, **1**, 128. Elliot, Phot. News, 1861, **5**, 293. Paul, Horn's Phot. J. 1854, **1**, 212.
- 14 This produces a darker brown than the iodide alone, but the negatives are apt to bleach in time.
- 15 C. Lea, Phot. Archiv. 1865, 184.
- 16 Burton and Laurie, Brit. J. Phot. 1881, **28**, 580.
- 17 Phot. News, 1861, **5**, 150. Cf. Phot. News, 1861 **5**, 170.
- 18 Rep. encycl. Phot. de la Blanchère, 1863, **3**, 23.

with ferrous sulfate; Lamb¹ combined potassium chlorate and pyrogallol; while Kaiser employed cupric chloride,² and Abney, cupric bromide.³ C. Lea⁴ proposed to bleach the image with potassium bichromate and HCl, and then applied sodium sulf-antimoniate, (Schlippe's salt), or H₂S. G. Selle⁵ conceived the idea of precipitating uranium ferrocyanide which is of an extremely non-actinic color on the silver image. Eder⁶ proposed potassium ferricyanide and a ferric salt, whereby Berlin blue would be precipitated on the image. J. Eder and Toth⁷ combined lead nitrate and potassium ferricyanide, precipitating lead and silver ferrocyanides. Treatment of the silver image with gold chloride (auric) gave a greyish blue image as the metallic gold partially replaced the silver.⁸ This was then treated with ammonium sulfide,⁹ or the acid-pyro intensifier,¹⁰ or ammoniacal pyro solution,¹¹ more intense images being obtained. Platinum tetrachloride or potassium chloroplatinite,¹² palladium and iridium chlorides,¹³ mixed mercuric and gold chlorides,¹⁴ or platinum and mercuric chlorides¹⁵ were also advocated.

Krüger¹⁶ stated that blowing air on to the shadows of the negative while developing acted as an intensifier; while Castellani¹⁷ enhanced the intensity by breathing on the plate.

Difficulties and Failures in Wet Collodion Process. In addi-

1. Brit. J. Phot. 1864, **11**, 371.
2. Bull. Belg. 1866, 103.
3. Phot. News, 1877, **22**, 171.
4. Humphrey's J. 1865; Fabre, Traité Ency. Phot. 1890, **2**, 111.
5. Bull. Belg. 1865; abst. Phot. Archiv. 1865, 236, 393.
6. Phot. Korr. 1876, 28. Cf. Phot. Korr. 1884; Phot. Mitth. 1884.
7. Phot. Korr. 1876, 10, 216, 221; Brit. J. Phot. 1876, **23**, 104, 140, 580; Fabre, Traité encyl. Phot. 1890, **2**, 112; Phot. News, 1879, **23**, 227.
8. Le Gray, Photographie, 1854, 142. Berry, Kreutzer's Jahr. Phot. 1855, 10; Horn's Phot. J. 1855, **2**, 48. Ramsay, Phot. Archiv. 1867, 304.
9. Berry, Kreutzer's Jahr. Phot. 1855, 10.
10. Le Gray, Photographie, 1854, 142. Leachman, Bull. Soc. Franc. Phot. 1877, 162.
11. C. Lea, Phot. News, 1876, **21**, 240. Jahr. Phot. 1877, 162.
12. M. Lyte, Phot. News, 1862; Monatsbl. 1862, **1**, 74. Simpson, Phot. Archiv. 1870, 252. Beyersdorff, Phot. Korr. 1872, 36. Eder and Toth, 1875, 237.
13. First recommended by Draper in 1858 or 1859, according to Schnauss, Phot. Lexicon, 1864, 271; Phot. Archiv. 1860, 17; Phot. News, 1873, 17.
14. W. Winter, Phot. Archiv. 1866, 63.
15. P. C. Duchochois, Amer. J. Phot. 1864; Phot. Archiv. 1864, 414; Phot. News, 1878, **22**, 263.
16. Brit. J. Phot. 1873, **20**, 306.
17. Phot. News, 1874, **19**, 148.

tion to the points touched upon briefly in the foregoing topics as to the manipulative details in this process, specific difficulties and how they may be overcome may be found discussed in the writings of J. Spiller,¹ M. Noton,² G. Dawson,³ C. Lea,⁴ W. Abney,⁵ M. Gaudin,⁶ J. Krüger,⁷ H. Hallier,⁸ E. Foxlee,⁹ H. Vogel,¹⁰ P. Rouaix,¹¹ S. Davis,¹² L. v. Babo,¹³ and Reynaud,¹⁴ to which the reader is referred for details.

*Dry Plates.*¹⁵ The disadvantages incident to the use of the

1. Brit. J. Phot. 1864, **11**, 286.
2. Proc. Man. Phot. Soc. Sept. 9, 1869, abst. Brit. J. Phot. 1869, **16**, 444.
3. Brit. J. Phot. 1880, **7**, 631.
4. Phot. News, 1871, **15**, 400. Brit. J. Phot. 1875, **22**, 219.
5. Brit. J. Phot. 1879, **26**, 38.
6. La Lumière, abst. Phot. News, 1861, **5**, 401.
7. Phot. World, abst. Brit. J. Phot. 1872, **19**, 126.
8. Brit. J. Phot. 1874, **21**, 173.
9. Brit. J. Phot. 1907, **54**, 445.
10. Phot. News, 1874, **18**, 310.
11. E. P. 3889, 1883; abst. Brit. J. Phot. 1883, **30**, 226.
12. Brit. J. Phot. 1868, **15**, 600.
13. Ber. Ges. f. Beford. d. Naturwiss. zu Freiburg im Breisgau, 1855, I; abst. Chem. Centr. 1855, **26**, 805; Dingl. Poly. 1855, **136**, 381; Jahr. Chem. 1850, **8**, 175; Horn's Phot. J. 1855, No. 9, 10; Pogg. Ann. 1856, **97**, 199; Pharm. J. June, 1856; Amer. J. Pharm. 1856, **28**, 440.
14. Phot. Jahr. **18**, 64.
15. In this connection see also the following references, all taken from the Bull. Soc. Franc. Phot. W. Abney, 1875, **21**, 129, 165; Bayard, 1855, **1**, 113; Blanc, 1869, **15**, 170; E. Boivin, 1857, **3**, 241; Bolton, 1868, **14**, 50; de Brebisson, 1864, **10**, 23, 26; Caron, 1855, **1**, 60, 1856, **2**, 34; Cels, 1864, **10**, 218; Cooper, 1873, **19**, 34; Chapman, 1868, **14**, 23; Clifford, 1857, **3**, 207; Chardon, 1873, **19**, 18; 1877, **23**, 88; I. Cassagne, 1856, **2**, 173, 341; de Constant-Delessert, 1868, **14**, 61, 286; 1871, **17**, 63; 1873, **19**, 90, 234, 272, 305; 1874, **20**, 107, 209; Davanne, 1876, **22**, 117; Davanne and Ferrier, 1877, **23**, 90; Dussol, 1870, **16**, 86; Duchochois, 1859, **5**, 282, 1860, **6**, 111; England, 1870, **16**, 235; FitzGibbon, 1861, **7**, 50; Fleury-Hermages, 1873, **19**, 82; Firmin and Lassimonne, 1856, **2**, 339; Gauthier Villars, 1876, **22**, 31; Gæume, 1856, **2**, 220; Geymet, 1875, **21**, 170; Hardwich, 1857, **3**, 16; 1859, **5**, 167; Harnecker, 1868, **14**, 13, 43; Hauck, 1875, **21**, 287; Himes, 1875, **20**, 10; P. Holland, 1871, **17**, 147; Haackmann, 1867, **13**, 293; Heisch, 1862, **8**, 239; Hislop, 1862, **8**, 54; Hannaford, 1862, **8**, 164; Jouet, 1859, **5**, 313; Kemp, 1864, **10**, 94; H. Krone, 1857, **3**, 245; M. Lea, 1865, **11**, 249; 1868, **14**, 106, 134, 156; 1861, **7**, 249, 252; Laveine, 1861, **7**, 116; L. Lisson, 1861, **7**, 211; Llewelyn, 1856, **2**, 182; Lyte, 1855, **1**, 206; Martin, 1874, **20**, 147; Magny, 1873, **19**, 190; Murray, 1878, **24**, 58; Macnair, 1860, **6**, 130; D. v. Monckhoven, 1871, **17**, 81; Meline and Montreuil, 1856, **2**, 342; Montreuil, 1858, **4**, 5; Miguski, 1859, **5**, 163; Maison, 1870, **16**, 93; R. Norris, 1856, **2**, 257; Newton, 1874, **20**, 39; Ommegeanck, 1869, **15**, 231; de Poilly, 1856, **2**, 220, 250; Phipps, 1869, **15**, 213; de Pitteurs, 1878, **24**, 211; Povarsky-Jaracko, 1874, **20**, 145; Paterson, 1860, **6**, 128; Quinet, 1857, **3**, 360; Robiquet and Duboscq, 1857, **3**, 18; Regnault, 1873, **19**, 102; Russel, 1864, **10**, 84, 127; Sanders, 1860, **6**, 244; 1863, **9**, 238; Spiller and Crookes, 1856, **2**, 271; J. Schnauss, 1865, **11**, 222; de Saint Florent, 1873, **19**, 318; T. Sutton, 1869, **15**, 197,

wet collodion process, particularly the necessity of preparing the plates immediately before exposure, led to many experiments with the purpose of obtaining a plate which could be kept for some time.¹ The first real step towards a dry process was made

253. G. Shadbolt, 1857, **3**, 54. Towler, 1868, **14**, 184. Taupenot, 1855, **1**, 279. Vogel, 1875, **21**, 172, 1876, **22**, 192. Violin, 1857, **3**, 157. F. de Villeholles, 1858, **4**, 4. Watson, 1874, **20**, 145. Anon 1856, **2**, 121, 339; 1861, **7**, 43, 1867, **13**, 257.

See further, Phot. Mitth* 1872, **8**, 108, 211, 230, 313, 1873, **9**, 41, 58, 210, 1876, **12**, 177, 1878, **14**, 240, 244, 1884, **20**, 29, 1894, **31**, 193; 1912, **49**, 271. H. Vogel, Ber 1873, **6**, 90. H. Norris, Phot. Archiv. 1889, 209, Phot. Corr 1889, Jahr Phot 1888, **2**, 324.

¹ For general information on the preparation, preservation, development and intensification of dry collodion plates, and their relative advantages or disadvantages over the wet collodion plates, consult: W. Abney, Phot. News, 1872, **16**, 159. M. Andreux, Phot. News, 1878, **22**, 355. A. Backnell, Phot. News, 1866, **10**, 440. H. Berkeley, Brit. J. Phot. 1878, **25**, 374. E. Boivin, Mon. Phot. 1877, **16**, 3, 137, 146, 155, 162, Chem. Tech. Rep. 1877, **16**, 1, 420. E. Borda, Phot. News, 1862, **6**, 200. J. Browne, Phot. News, 1895, **39**, 405. Bennett, Mon. Phot. 1867-1868, **7**, 63. A. de Brebisson, Mon. Phot. 1864-1865, **4**, 17. E. Chawner, Brit. J. Phot. 1866, **13**, 232, 1867, **14**, 373. M. Collard, Phot. News, 1858, **1**, 75. C. Corey, Brit. J. Phot. 1860, **7**, 322. A. de Constant, Phot. News, 1867, **11**, 416, 433, 1874, **21**, 85, Year Book Phot. 1871, 52. F. Dawson, Phot. News, 1878, **22**, 344. G. Dawson, Brit. J. Phot. 1862, **9**, 221. G. Davidson, Chem. Tech. Rep. 1868, **7**, 1, 83. P. Duchochois, Phot. News, 1859, **2**, 197, 233. Deleage, Phot. News, 1862, **6**, 369. Desprats, Phot. News, 1859, **2**, 29, 1862, **6**, 65, 295, 461, 1863, **7**, 100, 188, 1864, **8**, 76, Mon. Phot. 1864-1865, **4**, 15, 22. A. Davanne, Mon. Phot. 1865-1866, **5**, 71, Brit. J. Phot. 1874, **21**, 552, Phot. News, 1875, **19**, 3. J. Driffin, Phot. News, 1859, **2**, 50, 101, 109. E. Emerson, Brit. J. Phot. 1864, **11**, 75. W. England, Brit. J. Phot. 1862, **9**, 143. M. Eyraud, Phot. News, 1861, **8**, 18. J. Fox, Brit. J. Phot. 1871, **18**, 536. S. Fry, Phot. News, 1866, **10**, 231. A. Gaudin, Phot. News, 1860, **4**, 294. M. Gaudin, Phot. News, 1860, **4**, 171, Brit. J. Phot. 1860, **7**, 316, 1861, **8**, 64, 106. Gaedcke, Phot. Mitth. 1890, **27**, 107, Phot. News, 1890, **34**, 906. R. Norris, Amat. Phot. 1893, **18**, 132. J. Gough, Phot. News, 1872, **16**, 178, 188. P. Gaillard, Mon. Phot. 1865-1866, **5**, 43, 64. J. Glover, Brit. J. Phot. 1863, **10**, 342. C. Homes, Brit. J. Phot. 1874, **21**, 576. J. Hornsey, Year Book Phot. 1902, 217. P. Holland, Phot. News, 1870, **14**, 413. W. Hislop, Phot. News, 1861, **8**, 579, 1862, **6**, 568, Brit. J. Phot. 1861, **8**, 417, 1862, **9**, 142, 453. F. Hardwich, Brit. J. Phot. 1875, **22**, 461. T. Hardwich, Phot. News, 1859, **3**, 257, Brit. J. Phot. 1860, **7**, 19, 1875, **22**, 423; cf. Phot. News, 1860, **3**, 243, 267. B. Juilhed, Mon. Phot. 1864-1865, **4**, 6. Jane, Horn's Phot. Jahr **18**, 36. Jeanrenaud, Rep. chim. appl. 1863, **5**, 48. A. Keene, Phot. News, 1859, **2**, 134, 1862, **6**, 251; Brit. J. Phot. 1863, **10**, 158. J. Kirk, U. S. P. 136439, 1873. P. Kaiser, Mon. Phot. 1864-1865, **4**, 51. P. Liesegang, Mon. Phot. 1864-1865, **4**, 63. W. Lang, Phot. News, 1890, **34**, 533. M. Lea, Phila. Phot. abst. Phot. News, 1868, **12**, 80, 151, 1869, **13**, 344, Brit. J. Phot. 1868, **15**, 47, 605, 1869, **16**, 468, 1875, **22**, 508. Meline and Montreuil, Liverpool and Manchester Phot. J. 1857, **7**. D. Monckhoven, Chem. Tech. Rep. 1863, **2**, 11, 73. G. Muirhead, Brit. J. Phot. 1862, **9**, 87; reprint, 1905, **52**, 606. Norris, Phot. Soc. 1856, 84, 179; abst. Jahr. Chem. 1856, 188. G. Niewenglowski, La Photographie et la Photochemie, 1897, 73, 79. Newton, Mon. Phot. 1867-1868, **7**, 157. C. Ommeganck, Brit. J. Phot. 1869, **16**, 450, Phot. News, 1869, **13**, 343. H. Plamer, Brit. J. Phot. 1877, **24**, 208. M. Poitevin, Phot. News, 1860, **4**, 14. P. Piard, Phot.

by E. Robiquet and J. Duboscq¹ by the addition of resin to the

News, 1864, **8**, 90, Brit J Phot 1864, **11**, 117. Russell, Mon Sci 1862, **4**, 68; Phot News, 1862, **6**, 507, Brit J Phot 1863, **10**, 2, Phot Corr 1863, **20**, 340. Robertson, Mon Phot 1864 1865, **4**, 36. E. Robiquet and J. Duboscq, Compt rend 1856, **43**, 1191, abst. Poly. Centr. 1857, **23**, 468. Roman, Horn's Phot Jahr **16**, 15. C. Sedv, Brit J Phot 1860, **7**, 238. C. Sellers, Phot News, 1862, **6**, 201. J. Spiller, Year Book Phot 1886, 105. G. Shadbolt, Brit J Phot 1860, **7**, 47, 1861, **8**, 357. J. Schnauss, Mon Phot 1864 1865, **4**, 2, Phot News, 1864, **8**, 522, 1873, **17**, 315, 345. T. Sutton, Poly Centr. 1863, **29**, 698, Rep chim appl 1862, **4**, 385, Dmgd Poly 1863, **168**, 70; **169**, 345, Wied's Gewerbeztg 1863, 303, Phot News, 1860, **3**, 395, 1862, **6**, 193, abst. Rep chim appl 1863, **5**, 273. B. Sayce, Brit J Phot 1864, **11**, 38. G. Tissander, "History and Handbook of Phot." 1878, 170. L. Vidal, Phot News, 1863, **37**, 426. M. Verrier, Phot News, 1860, **4**, 229, 254, 1861, **8**, 159, 184. H. V. cel, Phot News, 1874, **20**, 255, Brit J Phot 1876, **23**, 546. H. Wortley, Phot. Mitth **13**, 142. See also Anon., Brit J Phot 1865, **12**, 592, 1866, **13**, 173, 283. 1867, **14**, 243, 349, 476, 509, 1868, **15**, 520, 1871, **18**, 317, 1872, **19**, 423, 1875, **22**, 487, 495, 1876, **23**, 326, 1878, **25**, 295, 384, 443, 1897, **44**, 427. Phot News, 1858, **1**, 178, 1859, **2**, 65, 142, 204, 1860, **3**, 215, 1861, **5**, 218, 1866, **10**, 265, 1872, **16**, 193, 1890, **34**, 579. M. Fourtier, Diet. pract. Chim. Phot 1892, 280. C. Fabre, Triente encycl. Phot 1890, **2**, 141, 159, 166, suppl. **2**, 247. A. Davanne, Les Progres de la Phot 1877, 26, 27, 30, 36. H. de la Blanchère, Rep. encycl. Phot 1863, **1**, 249. Mon Phot 1864 1865, **4**, 76, 1865 1866, **5**, 40, 1866 1867, **6**, 69, 95, 126, 1867 1868, **7**, 157, 1868 1869, **8**, 138, 1877, **16**, 189, 1879, **18**, 183. Horn's Phot Jahr **16**, 98. Eder's Jahr. Phot 1888, **2**, 466, 1890, **4**, 321, 324, 1895, **9**, 158, 1896, **10**, 473, 615, 1901, **15**, 615, 1903, **17**, 286, 1912, **26**, 475, 476, 1913, **27**, 391. Photography, 1891, **3**, 700, 1892, **4**, 401, 502, 516, 525, 1896, **8**, 47, 79, 1897, **9**, 380. G. Chancard, "La Photographie," 1909, 99, 100. Phot Bull **11**, 88. Phot Corr **17**, 216. Wilson's Cyclo Phot 1894, 93. Phot Annual, 1891, 81. Die Photographie, 1884, **1**, 50. Rep chim appl 1863, **5**, 276, 374. Poly Centr. 1861, **27**, 213, Dmgd Poly 1860, **158**, 318. Phot Mitth **8**, 153. Dmgd Poly 1855, **135**, 374. Amat Phot 1884, 78. Woodbury's Encycl. Diet. Phot 1896 1898, 119. Cassell's Encyl. Phot 1911, 120. Anthony's Phot Annual, 1890 1891, **3**, 288. E. Behn. Precis Phot Generale, 1905, **2**, 46.

For early English collodion patents see Archer, F. S., 1914, 1855. Beauregard, T., 3066, 1857. Bertrand, P. H. G., 1884, 1884, 1857. Cornides, L., 2112, 1855. Pem, J. H., 2363, 1859. Cutting, J. A., 1638, 1854. Ferrer, J. A., 2315, 1857. Lucenay, P. B. de, 575, 1852. Mabley, W. T., 693, 1852. Newton, F., 179, 1852. Newton, W. E., 1511, 1857. Norris, R. H., 2029, 1856. Parkes, A., 1123, 1856. Rollason, A., 770, 1855. Saillard, Benoit, 444, 1859. Sarony, O., 725, 1858. Sims, T., 341, 1859. Cornides, L., 2637, 1854. Pont, B., 309, 1855. Anthoai, C. G., 3024, 1860. Fargier, A. and R. Archbald, 955, 1861. Dixon, H., 1074, 1861. Hooman, T., and J. Mahszewski, 1089, 1861. Wilson, A. B., 1712, 1862. Marechal, C. R. and C. M. Tessie du Motay, 1060, 1861. Wothly, J., 2347, 1864. Truchelut, J. N., 2465, 1864. Smith, J. H., 915, 1865. Avet, H., 2110, 1865. Griswold, V. M., 3190, 1865. Grune, W., 3002, 1866.

1. Rev. Phot 1855, La Lumière, 1857, 29, Rep. encycl. Phot. de la Blanchère, 1863, **3**, 65. Kreutzer's Jahr. Phot 1856, 80, 1857, 198, Compt. rend. 1856, **43**, 1194, Horn's Phot J 1856, **7**, 51, Dmgd Poly 1859, **143**, 189; Jahr. Chem. 1856, **9**, 191. L. Enjolras, E. P. 7201, 1911, F. P. 424906, 1910; abst. J. S. C. I. 1911, **30**, 924, D. R. P. 257854, 1911 prepares highly sensitive collodion dry plates by combining the silver nitrate with the collodion and treating the film with bromating baths at 50° to 80° C., followed by a final bath containing a small amount of bromide and ammonium hydroxide. See E. Valenta, Phot. Korr 1912, **49**, 315, abst. C. A. 1912, **6**, 3096.

collodion, and by Despratz,¹ whose method was similar.² Practically the first real dry plate was made with ordinary collodion, sensitized in an aceto-nitrate bath, and coated with ordinary iodized or fermented albumen. In this condition, after drying, the plates were insensitive to light and would keep for a considerable time.

Various preservatives, however, were added to prolong the life of the plate, such as glycerol,³ raspberry syrup,⁴ honey,⁵ dextrin ratanhia and laudanum,⁶ guaiac,⁷ tannin,⁸ sugar,⁹ quassia and quassia camphor (whatever that is),¹⁰ catechu,¹¹ pyrogallie acid,¹² milk,¹³ quinquina,¹⁴ acacia,¹⁵ morphine,¹⁶ morphine acetate,¹⁷ tincture of nux vomica,¹⁸ and others.¹⁹

1. Rev. Phot. 1856; La Lumière, 1855, 202; Horn's Phot. J. 1856, **5**, 89; 1867, **11**, 12.
2. For data on substratum see W. Abney, Phot. News, 1881, **25**, 352. Barnes, Brit. J. Phot. 1873, **20**, 622. J. Glover, Brit. J. Phot. 1861, **8**, 436. W. Harrison, Brit. J. Phot. 1865, **12**, 479. M. Lea, Phot. News, 1868, **15**, 379; 1874, **18**, 280. E. Vogel, Brit. J. Phot. 1900, **47**, 436. H. Wortley, Brit. J. Phot. 1871, **18**, 504. Anon. Phot. News, 1873, **17**, 15; 1883, **27**, 674; Brit. J. Phot. 1861, **8**, 223; 1866, **13**, 215; 1871, **18**, 168; 1874, **21**, 181; 1881, **28**, 551; 1897, **44**, 182. Jahr. Phot. 1899, **13**, 505.
3. H. Dixon, Phot. News, 1874, **18**, 58. Rodger, Bull. Soc. Franc. Phot. 1859, **5**, 173.
4. J. Sisson, Phot. News, 1858, **1**, 125.
5. Hannot, Bull. Belge; abst. Phot. News, 1878, **22**, 279. See also Brit. J. Phot. 1876, **23**, 289. Phot. News, 1860, **4**, 226. M. Lyte, Phot. News, 1858, **1**, 42; Brit. J. Phot. 1869, **16**, 456.
6. M. de Saint Florent, Phot. News, 1874, **18**, 43.
7. T. Davis, Phot. News, 1878, **22**, 244.
8. W. Blair, Brit. J. Phot. 1871, **18**, 325. See also J. Moller, D. R. P. 24772, 1883.
9. M. Lea, Brit. J. Phot. 1868, Nov. 27th.
10. Anon., Brit. J. Phot. 1868, **15**, 395. Cf. Sleddon and Bolton, Bull. Soc. Franc. Phot. 1868, **14**, 272.
11. W. Craig, Phot. News, 1863, **7**, 470.
12. M. Lea, Phot. News, 1872, **16**, 583.
13. Edit. Phot. News, 1876, **20**, 613. Le Gray, Bull. Soc. Franc. Phot. 1857, **3**, 9.
14. Belbeze, Bull. Soc. Franc. Phot. 1873, **19**, 42, 59, 87.
15. M. Lea, Brit. J. Phot. 1876, **23**, 124.
16. H. Vogel, Phot. News, 1872, **16**, 463.
17. H. Vogel, Phot. News, 1872, **16**, 425.
18. J. M'Ghie, Brit. J. Phot. 1878, **25**, 28.
19. Coffee, Barratti, Brit. J. Phot. 1868, **15**, 240. Malt liquor, Davies, Brit. J. Phot. 1867, **14**, 360. Formic acid, Ferrier and Soulier, Brit. J. Phot. 1861, **8**, 200. Keeping plates under water, Mongin, Phot. News, 1868, **12**, 258. Syrup, Mansell, Bull. Soc. Franc. Phot. 1855, **1**, 54. Various substances, Mayall, Bull. Soc. Franc. Phot. 1855, **1**, 211. See also Vogel, Bull. Soc. Franc. Phot. 1875, **21**, 88. E. Vogel, Phot. Mitth. 1894, **31**, 165. A. Davanne, Bull. Soc. Franc. Phot. 1870, **16**, 171. H. Norris, Phot. Soc. 1856, **84**, 179; abst. Jahr. Chem. 1856, **9**, 188. Anon., Brit. J. Phot. 1861, **8**, 355; 1865, **12**, 495; 1867, **14**, 444, 458; 1871, **18**, March 24th. Dextrin, Chevreul,

R. Norris,¹ obtained a patent for the use of albumen and gelatin, the latter being also used by Bayard,² P. Duchochois³ and Meline and Montreuil,⁴ Fothergill,⁵ H. Petschler and Mann,⁶ Russell,⁷ W. England,⁸ Draper,⁹ Anthony,¹⁰ J. Mudd,¹¹ made improvements especially along the lines of preservatives.

H. Wortley,¹² pointed out that the preservative had the triple function of increasing sensitiveness, and producing greater density and vigor, so that the negatives were more suitable for printing. Resins were introduced by E. Robiquet and J. Duboscq,¹³ and Despratz,¹⁴ the latter preferring benzoin. Teschard,¹⁵ and Angerer¹⁶ recommended ordinary resin, while benzoin was preferred by Meynier,¹⁷ J. Glover¹⁸ and W. England.¹⁹ Jane²⁰ combined resin and dextrin.²¹ Many other resins were tried, as crude resin,²² jalap,²³ amber,²⁴ mastic, copal, and the guaiac of Boivin.²⁵

Compt. rend. 1855, **41**, 383; Horn's Phot. J. 1856, **3**, 102; Bull. Soc. Franc. Phot. 1856, 17; Silver Sunbeam, 1863, 237; Eder Handb. Phot. 1896, **2**, 519. See Law, Horn's Phot. J. 1854, **2**, 47.

1. E. P. 2029, 1856; abst. Hunt's Man. Phot. 336; Cosmos, 1857; Kreutzer's Jahr. 1857, 194. Liverpool and Manchester Phot. J. 1857, 108

2. See Bull. Soc. Franc. Phot. 1856, 307.

3. Phot. News, 1858, **1**, 183.

4. Liverpool and Manchester Phot. J. 1857, 7.

5. Phot. Archiv. 1860, 183.

6. Phot. Archiv. 1860. Hardwich Man. Phot. Chem. 1863. Phot. News, 1861, **5**, 316.

7. Phot. News, 1861, **5**, 135, 397. Brit. J. Phot. 1862, **9**, 26, 82, 130, 228. Silver Sunbeam, 1863, 245.

8. Phot. Archiv. 1862, 137.

9. Phot. Archiv. 1862, 117. See Rylay, Brit. J. Phot. 1864, **11**, 137. H. Wortley, Phot. News, 1862.

10. Eder Handb. Phot. 1896, **2**, 520.

11. Phot. News, 1861, **5**, 386; Kreutzer's Zts. 1861, **4**, 131. G. Simpson, Brit. J. Phot. 1861, **8**, 376; Kreutzer's Zts. 1861, **5**, 102.

12. Brit. J. Phot. 1876, **23**, 65.

13. See page 2827. Cf. Despratz, La Lumière, 1857, 35, 38; Kreutzer's Jahr. 1857, 198.

14. Mon. Phot. 1864; Horn's Phot. J. **21**, 23. Phot. Archiv. 1864, 287.

15. Kreutzer's Zts. 1860, **2**, 109.

16. Kreutzer's Zts. 1861, **4**, 203.

17. Phot. Archiv. 1862, **3**, 67.

18. Brit. J. Phot. 1860, **7**, 197; Kreutzer's Zts. 1860, 361. Phot. News, 1861, **5**, 161; abst. Kreutzer's Zts. 1861, **3**, 225; Brit. J. Phot. 1861, **8**, 373.

19. Phot. Mitth. 1867, **3**, 113.

20. Heinlein's Photographicon, 1864, 155; Phot. News, 1861, **5**, 504.

21. See also Regnault, Brit. J. Phot. 1873, **20**, 248.

22. Simo, Phot. Archiv. 1862, **1**, 44.

23. A. Keene, Phot. Archiv. 1863, **4**, 11.

24. E. Robiquet and J. Duboscq, see page 2827. W. England, Phot. Archiv. 1866, **7**, 284.

25. Phot. Archiv. 1866, **7**, 206. Mon. Phot. 1877; abst. Phot. Archiv. 1877, **18**, 210.

Copaiba,¹ mastic and oil of thyme,² and Peru and tolu balsams had their advocates.

Citron, rose and clove oils act very much like resins,³ oil of citron having been used by Boivin⁴ as a preservative with licorice juice, as oil of anise or vanilla delayed the light action. Gelatin was first used by R. Norris,⁵ either with alcohol, or made alkaline with ammonia, as in the Firmin and Lassimore method.⁶ The processes of C. Long,⁷ Berry,⁸ Beckingham,⁹ Bartholomew¹⁰ and H. Wortley¹¹ are similar. Meta-gelatin was the name given by M. Lyte to gelatin which had lost its property of setting by boiling with dilute acids, but which had not yet formed glyccoll.¹² T. Davis suggested albumen.¹³

The formulas of G. Shadbolt¹⁴ and of M. Lyte¹⁵ with honey, or the oxymel of Llewelyn,¹⁶ the treacle of Dauer¹⁷ and Merritt,¹⁸ sugar either neutral¹⁹ or slightly acidulated,²⁰ and caramel,²¹ with or without acacia in the hands of Johnson,²² Forster,²³ T. Sutton,²⁴

1 Phila Phot 1870, abst Phot Archiv 1870, **11**, 32, Deut Gewerbezg 1870, No. 6, Chem Tech Mitth 1869 1870, 154

2 Borie, La Lumiere, 1857, abst Horn's Phot J 1857, **7**, 43

3 Liebert, Phot en Amerique, 1878, 296 L Vidal, Brit J Phot 1862, **9**, 154

4 Bull Soc Franc Phot 1857, 313, Kreutzer's Jahr 1857, 196

5 Liverpool and Manchester Phot J. 1857, 19, Phot Notizen, 1857, 377, Kreutzer's Jahr 1857, 176

6 Bull Soc Franc Phot 1856, 339, Kreutzer's Jahr 1856, 76 See also A Davanne, Bull Soc Franc Phot 1867, 10, Kreutzer's Jahr 1857, 185.

7 Liverpool and Manchester Phot J 1857, 182, Kreutzer's Jahr. 1857, 182

8 Phot Notizen, 1857, 303, Kreutzer's Jahr 1857, 185

9 Horn's Phot J 1856, 163, 209, Kreutzer's Jahr 1857, 172

10 See Davanne's Progres de la Phot 1877, 23 T Sutton, "A New Wet Collodion Process," 1873, 13

11 See Wingrave, Brit J Phot 1861, **8**, 21.

12 Phot Mitth 1876, **13**, 142 Horn's Phot J 1857, **3**, 223, 287, Kreutzer's Jahr 1857, 185

13 Rep encycl de la Blanchere, 1863, **3**, 36

14 Horn's Phot J 1854, **2**, 4

15 Horn's Phot J 1856, **6**, 22

16 Horn's Phot J 1855, **3**, 24, Kreutzer's Jahr 1856, 67, La Lumiere, 1856, 153

17 Horn's Phot J 1856, **3**, 290, Kreutzer's Jahr 1857, 174.

18 Horn's Phot J 1857, **7**, 62

19 Merritt, La Lumiere, 1857, 29, Kreutzer's Jahr 1857, 173

20 Morgan, Horn's Phot J 1857, **4**, 24, 1859, **11**, 28, Kreutzer's Jahr. 1857, 175 See also Constant, Phot Archiv 1869, 10. Phot. Korr 1874, 45.

21 Bollmann, Phot. Monatsch 1862, 60. Phot. Korr 1874, 82.

22 Horn's Phot J 1857, **4**, 23, La Lumiere, 1857, 146, Kreutzer's Jahr 1857, 193

23 Brit J Phot 1860, **7**, 81; Kreutzer's Zts 1860, **2**, 235.

24 Phot Archiv 1862, 227, 1864, 55

and Blair and Adams¹ indicate the tendencies in this direction. T. Hardwich,² R. Gordon,³ H. Newton,⁴ Dubost,⁵ A. Keene⁶ and M. Lea⁷ all used gum with gallic acid or tannin

Dextrin was frequently used instead of gum arabic with similar results, as attested by the processes of Depuis,⁸ Boivin,⁹ Marimer,¹⁰ and Brebisson.¹¹ The albumen of Taupenot as modified by Fothergill,¹² and analogous methods of Bartholomew,¹³ Hannaford,¹⁴ Ackland,¹⁵ W. England,¹⁶ R. Gordon,¹⁷ Roman,¹⁸ and Howard and Clark¹⁹ are indicative of tendencies in this direction. Relatively unimportant modifications were advanced by Davis,²⁰ Constant,²¹ T. Sutton,²² Louzard,²³ and Nelson.²⁴

Tannin was first suggested by C. Russell,²⁵ the strength of solution varying from 0.5%–5%, remembering that the stronger the solution, the redder will the image appear at the commencement of development. Poitevin,²⁶ H. Vogel,²⁷ J. Glover,²⁸ A.

- 1 Brit J. Phot 1871, **18**, 359
- 2 Horn's Phot J 1860, **6**, 139, Kreutzer's Zts 1860, **1**, 47
- 3 Phot Archiv 1867, 389, 1869, 43. See also Phot Archiv 1868, 162, 1869, 10, 22, Phot Mitth 1869, 236
- 4 Phila Phot 1871, Archiv 1871, 290, Brit J Phot 1871, **21**, 542, 548
- 5 Phot Archiv 1873, 111
- 6 Phot. Archiv 1875, 313
- 7 Brit J. Phot 1870, **17**, 190. See also H. Wortley, Brit J Phot 1876, **23**, 124
- 8 La Lumière, 1856, 175, Kreutzer's Jahr 1856, 74
- 9 Brit J Phot 1866, **13**, 540
- 10 Horn's Phot J 1859, **11**, 43
- 11 Rep. encycl Phot de la Blanchère, 1863, **1**, 32
- 12 Phot News, 1861, **5**, 182, Brit J Phot 1864, **11**, 137
- 13 Eder's Handb. Phot 1896, **2**, 534
- 14 Brit J Phot 1861, **11**, 137
- 15 Phot Korr. 1866, 41
- 16 Phot Korr. 1866, 187
- 17 Phot Archiv 1866, 187
- 18 Rep. encycl. Phot de la Blanchère, 1863, **3**, 60
- 19 Phot News, 1861, **5**, 182
- 20 Phot Archiv 1866, 204
- 21 Phot Korr 1874, 86
- 22 Brit J Phot 1871, **18**, 211
- 23 See Fabre, Traité encycl Phot 1890, **2**, 39
- 24 Rep. encycl Phot de la Blanchère, 1863, **1**, 20
- 25 Phot. Archiv 1863, 244. "The Tannin Process," 1st Edit 1861, 2nd. Edit 1863, Phot News, 1861, **5**, 397, Brit J Phot 1863, **10**, 314. Communications regarding his process were also made by C. Russell in the Brit J Phot. 1861, **8**, 306, 362, 1862, **9**, 2, 26, 82, 130, 228, 1863, **10**, 136, 180, 314, 316; 1864, **11**, 303, 1867, **14**, 140, Phot News, 1861, **5**, 135, 155; 1862, **6**, 263; 1863, **7**, 193, 418, Bull Soc Franc Phot 1861, **7**, 107, 135, 140; 1864, **10**, 254; 1865, **11**, 68, 192
- 26 Phot. Korr. 1865, 56, Brit J Phot 1863, **10**, 476
- 27 Phot Archiv 1867, 139, 171.
- 28 Phot Archiv. 1864, 493.

Keene,¹ Kemp,² P. Gaillard,³ Browne,⁴ T. Sutton,⁵ Penny,⁶ C. Haack,⁷ Borlinetto⁸ and others⁹ have contributed to this subject.

Gallic acid was used by W. Talbot for calotype paper in 1841. Galloway and Cowan¹⁰ employed sodium acetate and gallic acid, and their process was improved upon and modified by M. Scherdtfeger,¹¹ R. Gordon,¹² A. de Constant,¹³ M. Lea,¹⁴ P. Duchochois¹⁵

1. Phot. Archiv. 1863, 11.
2. Phot. Archiv. 1863, 15.
3. Phot. Archiv. 1865, 275.
4. Phot. News, 1895, **39**, 405.
5. Phot. Notes, March 16, 1865.
6. Brit. J. Phot. 1865, **12**, 480.
7. Phot. Korr. 1867; Brit. J. Phot. 1867, **14**, 388.
8. Phot. Archiv. 1869, 144; Phot. News, 1873, **18**, 111; Bull. Soc. Franc. Phot. 1873, **19**, 105.
9. M. Andrieux, Phot. News, 1878, **22**, 419. J. Browne, Rep. chim. appl. 1863, **5**, 323. de Brebisson, Bull. Soc. Franc. Phot. 1863, **9**, 299. F. Borda, Phot. News, 1862, **6**, 382; Bull. Soc. Franc. Phot. 1862, **8**, 209. F. Beasley, Brit. J. Phot. 1871, **18**, 137. J. Brier, Phot. News, 1876, **20**, 194. W. Blair, Bull. Soc. Franc. Phot. 1871, **17**, 275. L. de Courten, Mon. Phot. 1865-1866, **5**, 69; Brit. J. Phot. 1873, **20**, 121. H. Cooper, Phot. News, 1862, **6**, 258. J. Celis, Phot. News, 1864, **8**, 346; Mon. Phot. 1864-1865, **4**, 73. M. Clavier, Phot. News, 1874, **18**, 114. A. Davanne, Phot. News, 1872, **16**, 352. G. Dawson, Brit. J. Phot. 1864, **11**, 4, 23, 399. W. England, Phot. News, 1862, **6**, 175. T. Fothergill, Brit. J. Phot. 1863, **10**, 421. C. Fabre, Phot. News, 1879, **23**, 506. J. Glover, Brit. J. Phot. 1862, **9**, 326. P. Gaillard, Bull. Soc. Franc. Phot. 1865, **11**, 123. Guenvin and Bonoldi, Bull. Soc. Franc. Phot. 1864, **10**, 313. Gaume, Bull. Soc. Franc. Phot. 1865, **11**, 290. J. Hughes, Brit. J. Phot. 1864, **11**, 313. H. Harvey, Brit. J. Phot. 1864, **11**, 122. T. Hardwich, Brit. J. Phot. 1861, **8**, 138. C. Himes, Brit. J. Phot. 1864, **11**, 114. H. Jennings, Phot. News, 1863, **7**, 617. W. King, Brit. J. Phot. 1863, **10**, 461. W. Keith, Brit. J. Phot. 1861, **8**, 176. G. Kemp, Brit. J. Phot. 1864, **11**, 18. A. Keene, Brit. J. Phot. 1862, **9**, 463. B. Sayce, Brit. J. Phot. 1864, **11**, 371. T. Sutton, Brit. J. Phot. 1863, **10**, 462; 1864, **11**, 196; Bull. Soc. Franc. Phot. 1864, **10**, 28. E. Saint Edme, Phot. News, 1863, **7**, 603. J. Möller, D. R. P. 24772, 1863. H. Newton, Phot. News, 1874, **18**, 500; Brit. J. Phot. 1874, **21**, 542. J. Taylor, Brit. J. Phot. 1864, **11**, 98. M. Towler, Bull. Soc. Franc. Phot. 1867, **13**, 44. Teisseire and Jacquemet, Mon. Phot. 1865-1866, **5**, 76, 94; Rep. chim. appl. 1863, **5**, 321. M. Vernier, Mon. Univers. March 30, 1864; Bull. Soc. Chim. 1864, **2**, 160; Brit. J. Phot. 1864, **11**, 152; Mon. Phot. 1864-1865, **4**, 4, 16. G. de Vylder, Phot. News, 1863, **7**, 377. Anon., Mon. Phot. 1865-1866, **5**, 48, 87; 1867, **13**, 131; 1873, **19**, 176. Phot. Jahr. **16**, 98. Phot. News, 1858, **1**, 103; 1859, **1**, 215; 1861, **5**, 121, 203, 397; 1862, **6**, 2, 217, 349; 1863, **7**, 573; 1871, **15**, 507. Brit. J. Phot. 1861, **8**, 121; 194, 316, 334; 1863, **10**, 376; 1864, **11**, 302, 385; 1865, **12**, 266, 298, 509; 1866, **13**, 220, 276, 301, 582; 1867, **14**, 524; 1868, **15**, 168, 204, 263; 1871, **18**, 265; 1873, **20**, 29, 40, 239, 263; 1895, **42**, 481.
10. Phot. News, 1861; Rep. encycl. Phot. de la Blanchère, 1863, **3**, 22.
11. Phot. News, 1872, **16**, 391.
12. Bull. Soc. Franc. Phot. 1873, **19**, 174. Brit. J. Phot. 1869, **16**, 289, 323.
13. Phot. News, 1873, **18**, 333.
14. Brit. J. Phot. 1868, **15**, 24, 36; Bull. Soc. Franc. Phot. 1868, **14**, 106.
15. Phot. News, 1858, **1**, 146.

and others workers,¹ along similar lines.

Morphine hydrochlorate was suggested by Mackinlay in 1859, revived by Bartholomew,² and extended to new photographic application by Towler,³ H. Vogel,⁴ J. Schnauss⁵ and H. Newton.⁶ Saint-Florent⁷ preferred laudanum. H. Vogel contended that morphine acted four times as strongly as tannin.⁸

The coffee process was suggested by Barratti,⁹ and modified by A. de Constant,¹⁰ Angerer,¹¹ and J. Schnauss.¹² H. Newton discovered the tea process,¹³ which was improved upon by M. Lea,¹⁴ Hoenig,¹⁵ Belbeze,¹⁶ Kaiser¹⁷ and later by H. Newton¹⁸ who used mustard seeds with the tea.

At the British Association for the Advancement of Science meeting in 1871, R. Hunt¹⁹ described a highly sensitive paper prepared with silver iodide and potassium ferrocyanide, and E. Reynolds²⁰ suggested this for dry plate work. To this, Rossig²¹ added glycerol. Grüne used casein and ammonia, while beer was introduced by Abney in 1874 for the transit of Venus expedition.²² Duchy²³ preferred porter. Champagne²⁴ (probably only for those who could afford it), claret and tobacco,²⁵ ginger wine

1. Brit. J. Phot. 1866, **13**, 364; 1867, **14**, 362; 1868, **15**, 59, 1873, **20**, 251.
2. Chem. Tech. Rep. 1870, **9**, I, 81, 84.
3. Phot. News, 1872; Phot. Mitth. 1872, **9**, 71.
4. Silver Sunbeam, 1866, 482; Phot. Archiv. 1868, 98.
5. Phot. Mitth. 1872, **9**, 115.
6. Phot. Archiv. 1873, 74.
7. Phot. Archiv. 1869, 219.
8. Bull. Soc. Franc. Phot. 1873, 318. Anthony's Bull. 1875; Phot. Mitth. 1875, 228.
9. See Boivin, Brit. J. Phot. 1877, **24**, 315; Mon. Phot. 1877.
10. Camera Obscura 1865; Phot. Archiv. 1865, 261; Brit. J. Phot. 1868, **15**, 248; Silver Sunbeam, 1869, 483.
11. Phot. Archiv. 1866, 403; 1867, 229; 1868, 14, 114; 1869, 219; Brit. J. Phot. 1868, **15**, 240; 1877, **24**, 315.
12. Phot. Korr. 1873, 204.
13. Phot. Archiv. 1872, 61.
14. Silver Sunbeam, 1869, 494.
15. Brit. J. Phot. 1871; Phot. Archiv. 1871, 264.
16. Phot. Jahr. 1875.
17. Bull. Soc. Franc. Phot. 1869, 34.
18. Phot. Archiv. 1865, 88.
19. Anthony's Phot. Bull. 1873; Bull. Soc. Franc. Phot. 1874, 39.
20. Researches on Light, 2nd ed. 1854, 91.
21. Brit. J. Phot. 1865, **12**, 495.
22. Phot. Korr. 1866, June. Brit. J. Phot. 1866, **13**, 300.
23. Instructions on Phot. 1882, 112; 10th ed. 1900, 270.
24. Phot. Archiv. 1866, 115.
25. Bell, Brit. J. Phot. 1860; Kreutzer's Zts. 1860, 36.
26. Brit. J. Phot. 1877, **24**, 329. Mon. Phot. 1877.

and malt vinegar,¹ milk,² tobacco,³ fir shoots,⁴ mastic, sumac or catechu,⁵ extract of rhatarry,⁶ raisins,⁷ jujube paste,⁸ licorice,⁹ quassia,¹⁰ safflower,¹¹ starch,¹² linseed,¹³ iceland moss,¹⁴ quince seed,¹⁵ and many other things¹⁶ which might contain sugar, starch or alkaloids.

M. Lea advocated soap liniment,¹⁷ alcoholic camphor, oil of

- 1 Davis, Phot Archiv 1866, 203
 - 2 G Le Gray, Bull. Soc. Franc. Phot 1857, 9; Kreutzer's Jahr 1857, 197; Anthony, Liebert Phot en Amerique, 1878, 271 Heinlein's Photographicon, 1864, 153
 - 3 Boivin, Mon Phot 1877, Brit J. Phot 1877, **24**, 329
 - 4 Dussol, Phot Archiv 1870, 164, Bull Soc. Franc. Phot 1870, 86
 - 5 Craig, Phot News, 1864, Bollmann's Phot. Monatsh 1864, 449.
 - 6 Saint Florent, Bull. Soc. Franc. Phot 1873, 318
 - 7 J. Schnauss, Phot. Archiv 1864, 335
 - 8 de Diebisson, Phot Archiv 1864, 163
 - 9 Boivin, Bull Soc. Franc. Phot 1857, 313; Kreutzer's Jahr. 1857, 196
 - 10 Bolton, Brit J Phot 1868, Bull Soc. Franc. Phot 1868, 272, Phot Mitth. 1868, **5**, 140 Sleddon, Licht, 1870, 79
 - 11 Fowler, Aide Memoire Phot 1877, 44
 - 12 Used by Lord Lindsay for the transit of Venus expedition, 1874.
 - 13 Ziegler, Kreutzer's Jahr 1856, 84 Jagor, Phot Archiv 1864, 20
 - 14 Agner, Phot Archiv
 - 15 Boivin, Kreutzer's Jahr 1857, 194
 - 16 Caramel, W Bartholomew, Phot News, 1862, **6**, 4 Malt, D. Drummond, Brit J Phot 1863, **10**, 444 Infusion of nux vomica, Brit J. Phot. 1869, **16**, 28 Caseme, P. Duchochoux, Phot News, 1858, **1**, 183 Albumen and beer, Brit J Phot 1874, **21**, 372 Serum, A Povorski-Jovavko, Brit J Phot. 1874, **21**, 195 Resin, A Robb, Brit J Phot. 1862, **9**, 188 Whey, A de Povorsky-Joranko, Phot News, 1874, **18**, 176 Formic acid, T Malone, Brit J. Phot 1863, **10**, 300 See also Luppö-Cramer, C. A. 1916, **10**, 1014
 - 17 Brit J Phot 1868, **15**, 33
- The albumen-collodion process was in vogue for a considerable time, and was discussed in great detail, as evidenced by the communications of H Anthony, Brit J Phot 1870, **17**, 492 W. Abney, Phot News, 1871, **15**, 607, 617. W Ackland, Brit J. Phot 1865, **12**, 630; Bull Soc. Franc. Phot 1860, **6**, 321 S Bourne, Brit J. Phot 1862, **9**, 6 Bayard, Bull Soc. Franc. Phot 1858, **4**, 39 de Belbeze, Bull S&C Franc. Phot. 1873, **19**, 42, 59, 87. J Briet, Phot News, 1874, **18**, 489, Brit J. Phot 1876, **23**, 197 W. Bartholomew, Phot News, 1861, **5**, 215 J. Beldon, Brit J. Phot. 1862, **9**, 275 A Burns, Brit J Phot 1861, **8**, 144 W Blair, Brit J Phot. 1869, **16**, 362 E. Borda, Brit J. Phot 1862, **9**, 210 E Boivin, Phot News, 1876, **20**, 150; 1877, **21**, 2, 581 W. Coote, Brit. J Phot. 1872, **19**, 37, 67. J. Cowan, Phot News, 1861, **5**, 349, Bull Soc. Franc. Phot 1861, **7**, 209. Crawford, Poly. Centr 1855, **21**, 175. Clouzard, Phot. News, 1873, **17**, 453; Bull Soc. Franc. Phot. 1873, **19**, 179. M. Carbutt, Brit. J. Phot. 1873, **20**, 483. P. Champion, Bull Soc. Franc. Phot 1867, **13**, 226 R. Carlyle, Phot. News, 1867, **11**, 177. T Clark, Phot. News, 1859, **2**, 178. T. Clarke, Brit. J. Phot. 1877, **23**, 11. A Clark, Phot. News, 1876, **20**, 590. W. Clark, Phot. News, 1863, **7**, 247. J. Cramb, Brit. J. Phot. 1861, **8**, 181; Phot. News, 1861, **5**, 293. A. de Constant, Bull. Soc. Franc. Phot. 1873, **234**, 272, 305; 1874, 107, 209; Phot. News, 1873, **17**, 608. W. Davies, Brit. J.

rosemary, or preferably tincture of aloes as being especially valuable.

Phot. 1874, **21**, 278. Phot. News, 1874, **18**, 285. A. Davanne and P. Gaillard, Bull. Soc. Franc. Phot. 1857, **3**, 9, 1858, **4**, 156. A. Davanne, Phot. News, 1859, **2**, 234. P. Duchochois, Phot. News, 1891, **35**, 636, 716. T. Davis, Phot. News, 1861, **5**, 90, 129, 1866, **10**, 187, 1867, **11**, 236, Brit. J. Phot. 1861, **8**, 86, 1867, **14**, 230, 1872, **19**, 277, Bull. Soc. Franc. Phot. 1861, **7**, 190, Phot. Jahr **16**, 50. W. England, Brit. J. Phot. 1867, **14**, 181, Bull. Soc. Franc. Phot. 1867, **13**, 206, Mon. Phot. 1867, 1868, **7**, 30, Phot. Mitth. 1868, **4**, 59. C. Fabre, Bull. Soc. Franc. Phot. 1879, **25**, 253. Falconer, Bull. Soc. Franc. Phot. 1887, (2), **3**, 89. Fothergill, Bull. Soc. Franc. Phot. 1858, **4**, 263. Ferrier, Bull. Soc. Franc. Phot. 1878, **24**, 317. G. Griffiths, Brit. J. Phot. 1866, **13**, 556. W. Griffiths, Brit. J. Phot. 1860, **7**, 111. E. Gordon, Brit. J. Phot. 1873, **20**, 338. R. Gordon, Brit. J. Phot. 1866, **13**, 522; Phot. News, 1867, **11**, 269, Phot. Mitth. 1867, **3**, 97. Gatel, Bull. Soc. Franc. 1858, **4**, 79. F. Gage, Phot. News, 1860, **4**, 205. S. Geoffroy, Phot. News, 1867, **11**, 305; Brit. J. Phot. 1867, **14**, 405. W. Hslop, Brit. J. Phot. 1861, **8**, 394, Phot. News, 1862, **6**, 95. D. Hornby, Brit. J. Phot. 1866, **13**, 300. F. Howard, Brit. J. Phot. 1861, **8**, 87, Phot. News, 1861, **5**, 99. P. Jeuffran, Phot. News, 1867, **11**, 65, Bull. Soc. Franc. Phot. 1867, **13**, 8. N. Jocelyn, Phot. News, 1866, **10**, 379, 389, 1867, **11**, 322. A. Keene, Phot. News, 1858, **1**, 87, Bull. Soc. Franc. Phot. 1860, **6**, 247. H. Krone, Phot. Times, 1875, **5**, 290. Lund, Mon. Phot. 1877, **16**, 158. J. Law, Brit. J. Phot. 1864, **11**, 41. M. Lea, Phot. News, 1874, **18**, 289. P. Laesgaard, Phot. News, 1871, **15**, 489. Maxwell Lyte, Phot. News, 1867, **11**, 327, Bull. Soc. Franc. Phot. 1867, **13**, 112, Mon. Phot. 1867, 1868, **7**, 61, 110. W. Moens, Phot. News, 1861, **5**, 518. D. Van Monckhoven, Brit. J. Phot. 1871, **18**, 303. G. Markham, Brit. J. Phot. 1870, **17**, 363. M. Magny, Phot. News, 1873, **17**, 270. Maddos, Bull. Soc. Franc. Phot. 1860, **6**, 46. Martens, Bull. Soc. Franc. Phot. 1861, **7**, 80. J. Mudd, Phot. News, 1861, **5**, 380, 1866, **10**, 266, Brit. J. Phot. 1860, **7**, 67, 1866, **13**, 286. J. Nicol, Phot. News, 1858, **1**, 122. H. Nichols, Phot. News, 1861, **5**, 231. A. Nelson, Phot. News, 1859, **2**, 146. M. Noton, Phot. News, 1861, **5**, 571, Brit. J. Phot. 1871, **18**, 231, Bull. Soc. Franc. Phot. 1862, **8**, 21. T. Prumm, Phot. News, 1872, **16**, 521. A. Potevin, Brit. J. Phot. 1873, **20**, 139. Parson, Phot. Jahr **16**, 75. Price, Bull. Soc. Franc. Phot. 1870, **16**, 240, 1873, **19**, 24. J. Parry, Brit. J. Phot. 1860, **7**, 267. J. Pollitt, Brit. J. Phot. 1875, **22**, 497. F. Pickerell, Phot. News, 1875, **19**, 113. J. Paar, Phot. Mitth. 1865, **31**, 154, 168. H. Petschler, Brit. J. Phot. 1861, **8**, 215, 1864, **11**, 511, 1867, **14**, 140, Phot. News, 1861, **5**, 316, Bull. Soc. Franc. Phot. 1860, **6**, 254. F. Richards, Phot. News, 1861, **5**, 11. Roche, Bull. Soc. Franc. Phot. 1874, **20**, 13. J. Ryley, Brit. J. Phot. 1860, **7**, 367, Phot. News, 1860, **4**, 374. G. Roman, Phot. News, 1861, **5**, 302, 311, Bull. Soc. Franc. Phot. 1861, **7**, 200, 1863, **9**, 93. J. Schnauss, Phot. News, 1873, **17**, 229. J. Sidebotham, Phot. News, 1858, **1**, 170. T. Sutton, Phot. News, 1862, **6**, 365, Brit. J. Phot. 1871, **18**, 199, 1873, **20**, 259. J. Tawse, Phot. News, 1861, **5**, 566. G. Thomson, Phot. News, 1877, **21**, 231. J. Taylor, Brit. J. Phot. 1864, **11**, 137. Taupenot, Bull. Soc. Franc. Phot. 1855, **1**, 231, 1856, **1**, 17. Towler, Bull. Soc. Franc. Phot. 1867, **13**, 44. J. Underwood, Phot. News, 1862, **6**, 274. H. Vogel, Phot. News, 1875, **19**, 379. H. and J. Walter, Phot. News, 1862, **6**, 430. F. Wenderoth, Brit. J. Phot. 1866, **13**, 72. W. Woodward, Phot. News, 1859, **3**, 305. G. Wardley, Chorlton Phot. Assoc., Sept. 12, 1861; abst. Phot. News, 1861, **5**. J. Whitehouse, Phot. News, 1875, **19**, 119. J. Ward, Phot. News, 1862, **6**, 83. M. Willet, Phot. News, 1860, **4**, 43. Anon., Brit. J. Phot. 1861, **8**, 165, 248, 1866, **13**, 184, 319, 484, 531, 1867, **14**, 108, 342, 432, 480, 521; 1868, **15**, 180, 193, 244; 1869, **16**, 457, 1871, **18**, 211, 471; 1873, **20**, 179, 203, 215, 227, 287, 347, 1875, **22**, 169, 481. Phot. News, 1858, **1**, 145, 160, 1859, **2**, 131, 143, 189, 275, 303; 1861, **5**, 53, 182, 197, 207; 1864, **8**, 539; 1867, **11**, 243, 523; 1871, **15**, 483, 505. Phot. Mitth. 1912, **49**,

Collodion Emulsions. Notwithstanding the advances made by the dry plate process as compared with wet collodion, the former was still unsatisfactory in many respects, especially in regard to facility of preparation, and many were the experiments made to produce "negatives without nitrate of silver bath."¹ In

354. *Eder Jahr. Phot.* 1896, **10**, 473; 1901, **15**, 645. *Mon. Phot.* 1864-1865, **4**, 136; 1865-1866, **5**, 125. *Chem. Tech. Rep.* 1872, **11**, I, 113. *Bull. Soc. Franc. Phot.* 1858, **4**, 29, 275; 1861, **7**, 49; 1873, **19**, 119.

The manifold causes of failure in the manipulation of dry plates, such as fog, pinholes, staining, uneven development, blisters, etc., are also discussed by M. Lea, *Brit. J. Phot.* 1868, **15**, 494. M. Gaudin, *Phot. News*, 1861, **5**, 374. S. M'Watters, *Brit. J. Phot.* 1867, **14**, 512. W. Brooks, *Phot. News*, 1873, **18**, 521. Anon., *Brit. J. Phot.* 1867, **14**, 448; 1868, **15**, 503, 603; 1871, **18**, 172; 1873, **20**, 613; 1875, **22**, 242, 578; 1877, **24**, 130, 517, 544. *Mon. Phot.* 1862-1863, **2**, 54; 1864-1865, **4**, 129, 136; 1865-1866, **5**, 189; 1866-1867, **6**, 62, 155.

Burton, *Phot. News*, 1880, **24**, 554. Lanjarrois, *Phot. Jahr.* **18**, 45. Maxwell Lyte, *Bull. Soc. Franc. Phot.* 1857, **3**, 81, 339. R. Norris, *E. P.* 2029, 1856; 7044, 1888; *abst. Poly. Centr.* 1857, **23**, 394; *Phot. News*, 1880, **24**, 595; *Brit. J. Phot.* 1893, **40**, 479. See *Phot. News*, 1889, **33**, 214. H. Vogel, *Bull. Soc. Franc. Phot.* 1880, **26**, 145. J. Wingrave, *Brit. J. Phot.* 1861, **8**, 21. H. Wortley, *Phot. Mitth.* 1877, **13**, 136, 172. Anon., *Phot. News*, 1859, **1**, 296; 1876, **20**, 311. *Brit. J. Phot.* 1861, **8**, 349; 1869, **16**, 612; 1876, **23**, 307; 1877, **24**, 194.

Additional information regarding the development of dry plates will be found by consulting W. Abney, *Brit. J. Phot.* 1879, **26**, 469; *Phot. Bull.* 1879, **10**, 338. W. Brooks, *Brit. J. Phot.* 1876, **23**, 185. Blanc, *Bull. Soc. Franc. Phot.* 1868, **14**, 87. de Belbeze, *Bull. Soc. Franc. Phot.* 1869, **15**, 291. Coventry, *Bull. Soc. Franc. Phot.* 1867, **13**, 265. Decagny, *Bull. Soc. Franc. Phot.* 1868, **14**, 201. G. Dawson, *Brit. J. Phot.* 1881, **28**, 328. W. Davies, *Brit. J. Phot.* 1869, **16**, 492. A. Davanne, *Bull. Soc. Franc. Phot.* 1876, **22**, 93. M. Gaudin, *Brit. J. Phot.* 1862, **9**, 268. Howards, *Bull. Soc. Franc. Phot.* 1869, **15**, 231. H. Jennings, *Phot. News*, 1859, **2**, 143. A. Levy, *Brit. J. Phot.* 1879, **26**, 393. Nelson, *Bull. Soc. Franc. Phot.* 1869, **15**, 241. Plücker, *Bull. Soc. Franc. Phot.* 1875, **21**, 109. J. Swan, *Phot. News*, 1880, **24**, 51. G. Simpson, *Phot. News*, 1861, **5**, 518. T. Sutton, *Brit. J. Phot.* 1863, **10**, 496. A. Verity, *Brit. J. Phot.* 1863, **10**, 26. G. Williams, *Brit. J. Phot.* 1865, **12**, 164. H. Wortley, *Brit. J. Phot.* 1871, **18**, 350. Anon., *Phot. News*, 1859, **1**, 236; 1878, **22**, 473; *Brit. J. Phot.* 1862, **9**, 317; 1873, **20**, 275, 278; 1876, **23**, 133, 193; 1878, **25**, 36, 362.

1. For general information on the preparation of collodion emulsions see W. Abney, *Bull. Soc. Franc. Phot.* 1879, **25**, 60, 173, 200; 1881, **27**, 36, 105. *Phot. News*, 1880, **24**, 146. *Brit. J. Phot.* 1881, **28**, 377. Anthony's *Phot. Bull.* 1879, **10**, 338. Albert, *Bull. Soc. Franc. Phot.* 1888, (2), **4**, 283. W. Ashman, *Phot. News*, 1889, **33**, 373. C. Audra, *Brit. J. Phot.* 1878, **25**, 278; *Bull. Soc. Franc. Phot.* 1877, **23**, 121, 150, 206, 316; 1879, **25**, 122, 175. Balagny, *Bull. Soc. Franc. Phot.* 1877, **23**, 178; 1879, **25**, 124. E. Banks, *Bull. Soc. Franc. Phot.* 1883, **29**, 89; *Brit. J. Phot.* 1883, **30**, 202, 339, 373; 1895, **42**, 165. C. Bardy, *Bull. Soc. Franc. Phot.* 1877, **23**, 221; 1879, **25**, 122, 210; *Chem. Tech. Rep.* 1879, **18**, II, 185; *Phot. News*, 1877, **21**, 476. F. Beach, *Brit. J. Phot.* 1889, **36**, 25, 40. St. V. Beechey, *Brit. J. Phot.* 1871, **18**, 541; 1876, **23**, 71; 1905, **52**, 767. Bennett, *Bull. Soc. Franc. Phot.* 1879, **25**, 80. H. Berkeley, *Brit. J. Phot.* 1874, **21**, 20, 152; 1877, **24**, 20, 296; *Phot. News*, 1877, **21**, 291, 302; *Bull. Soc. Franc. Phot.* 1877, **23**, 246; 1879, **25**, 89. Berwick, *Bull. Soc. Franc. Phot.* 1880, **26**,

general, however, it may be safely said that these negatives

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did not, in general, fulfil the expectations claimed for them.

49. A. Mackie, Brit. J. Phot. 1887, **34**, 294; Phot. News, 1897, **41**, 190. G. Marekham, Brit. J. Phot. 1872, **19**, 411; 1873, **20**, 451. Martin, Bull. Soc. Franc. Phot. 1877, **23**, 283. A. Mathison, Brit. J. Phot. 1878, **25**, 220, 223. P. Mawdsley, Phot. News, 1877, **21**, 111; Brit. J. Phot. 1877, **24**, 112; Bull. Soc. Franc. Phot. 1879, **25**, 200. D. v. Monckhoven, Bull. Soc. Franc. Phot. 1879, **25**, 200, 204. H. Newton, Phot. News, 1875, **19**, 352; 1876, **20**, 382, 1877, **21**, 400. R. Murray, Phot. News, 1878, **22**, 57. J. Monsoht, Chem. Tech. Rep., 1879, **18**, 11, 187; Bull. Soc. Franc. Phot. 1879, **25**, 199. Muncey, Bull. Soc. Franc. Phot. 1889, (2), **5**, 37. H. Norris, Chem. Centr. 1889, **60**, 11, 427. Jahr Chem. 1889, **42**, 2878. J. Obernetter, Phot. News, 1878, **22**, 206, 303, Brit. J. Phot. 1878, **25**, 206, Bull. Soc. Franc. Phot. 1879, **25**, 143. Ogilvy, Bull. Soc. Franc. Phot. 1879, **25**, 144. J. Payne, Brit. J. Phot. 1883, **30**, 317. Peligot and Bardy, Bull. Soc. Franc. Phot. 1879, **25**, 61, 122. Penrose & Co., Phot. News, 1898, **42**, 776. Perrot, Bull. Soc. Franc. Phot. 1877, **23**, 124. Phips, Bull. Soc. Franc. Phot. 1874, **20**, 310. M. de Pitteurs, Brit. J. Phot. 1879, **26**, 386. J. Plener, D. R. P. 20733, 1882, E. P. 4896, 1881. Plucker, Bull. Soc. Franc. Phot. 1873, **19**, 275. J. Poirin, Chem. Tech. Rep. 1884, **23**, 1, 164, Brit. J. Phot. 1885, **32**, 366. Roche, Bull. Soc. Franc. Phot. 1876, **22**, 33. Roger, Bull. Soc. Franc. Phot. 1879, **25**, 95. Romelaere, Bull. Soc. Franc. Phot. 1879, **25**, 273. Rossignol, Bull. Soc. Franc. Phot. 1876, **22**, 178; 1880, **26**, 296. Roy, Bull. Soc. Franc. Phot. 1881, **27**, 65. Sayee and Bolton, Bull. Soc. Franc. Phot. 1865, **11**, 16, 260. Singer, Bull. Soc. Franc. Phot. 1876, **22**, 48. Stebbing, Bull. Soc. Franc. Phot. 1879, **25**, 13, 90, 124. Spurrier, Brit. J. Phot. 1868, **15**, 82. F. Wilde and S. Stein, Phot. News, 1878, **22**, 160. W. Stillman, Brit. J. Phot. 1872, **19**, 421, 433; Bull. Soc. Franc. Phot. 1874, **20**, 311. T. Sutton, Brit. J. Phot. 1871, **18**, 139, 235, 271, 391, 439, 460, 566, 1872, **19**, 67, 122; 1873, **20**, 62; 1874, **21**, 351, 392, Bull. Soc. Franc. Phot. 1871, **17**, 295. L. Vidal, Brit. J. Phot. 1880, **27**, 460. F. Villecholle, Bull. Soc. Franc. Phot. 1877, **23**, 13. E. Vogel, Phot. Mitth. 1895, **31**, 165, 1898, **34**, 203; 1899, **36**, 45. H. W. Vogel, Brit. J. Phot. 1880, **27**, 549; 1881, **28**, 317, 1884, **31**, 73, Phot. News, 1871, **15**, 477, U. S. P. 235831, 1880, abst. Brit. J. Phot. 1882, **29**, 52; E. P. 2162, 1880, abst. Brit. J. Phot. 1881, **28**, 110, D. R. P. 12416, 13726; abst. Wag. Jahr. 1880, **26**, 903; Ber. 1881, **14**, 385, Bull. Soc. Chim. 1881, **36**, 192, Zts. prakt. Phot. 1880, **2**, 56. Vogel, Phot. Mitth. 1871, **8**, 117; 1883, **20**, 97, Bull. Soc. Franc. Phot. 1881, **27**, 81, 1889, (2), **5**, 34. Walkmer, Bull. Soc. Franc. Phot. 1881, **27**, 36. L. Warniercke, Phot. Mitth. 1876, **12**, 301, Chem. Tech. Rep. 1876, **15**, 1, 321, Bull. Soc. Franc. Phot. 1876, **22**, 69, 119, 1879, **25**, 285, 287. Wellington, Bull. Soc. Franc. Phot. 1891, (2), **7**, 188. W. Wilkinson, Brit. J. Phot. 1883, **30**, 324, Bull. Soc. Franc. Phot. 1869, **15**, 235, 1881, **27**, 213. Window, Chem. Tech. Rep. 1872, **11**, 1, 115. J. Wolfram, E. P. 847, 1880. H. Wortley, Phot. News, 1872, **16**, 61, 419; 1873, **17**, 429, 1876, **20**, 293, 504, Bull. Soc. Franc. Phot. 1871, **17**, 308, 1872, **18**, 49; 1876, **22**, 35, 109; Phot. Mitth. 1872, **8**, 90, 1877, **13**, 142; Chem. Tech. Rep. 1872, **11**, 1, 109, Brit. J. Phot. 1872, **19**, 31, 62, 169, 276, 296, 403, 1873, **20**, 321; 1875, **22**, 587, 1876, **23**, 125; 1883, **30**, 76. W. Wood, Phot. News, 1879, **23**, 244. T. Woods, Phil. Mag. 1854, **8**, 24, 213, Dingl. Poly. 1854, **134**, 126, 127, Ann. 1852, **92**, 221; Arch. ph. nat. 1854, **26**, 357, Jahr Chem. 1854, **7**, 194. Wratten, Bull. Soc. Franc. Phot. 1877, **23**, 282. Stillman, Bull. Soc. Franc. Phot. 1874, **20**, 23. H. Berkeley, Bull. Soc. Franc. Phot. 1877, **23**, 246.

Further information may be obtained by consulting Amat. Phot. 1891, **13**, 367; 1892, **15**, Q-295, A-313, 1899, **30**, 66, 1903, **38**, 179, 279. Phot. Times, 1888, **18**, 144, 1890, **20**, 170. J. Phot. 1892, **39**, 211. Photography, 1890, **2**, 458, 1891, **3**, 466; 1892, **4**, 383, 898; 1894, **6**, 625, 1897, **9**, 109; 1900, **12**, 217. Anthony's Phot. Ann. 1889, **2**, 374; 1890-1891, **3**, 231. Phot. Annual, 1892, 61, 83; 1893, 65, 109; 1895, 166; 1898, 92, 93, 96. Jahr. Phot.

M. Gaudin,¹ Bellini,² H. Dixon,³ W. Bolton and B. Sayce,⁴ R. Liesegang,⁵ T. Sutton,⁶ M. Lea,⁷ E. Phipps,⁸ H. Newton,⁹ Mawdsley,¹⁰ H. Wortley,¹¹ Laborde¹² and W. Bolton¹³ may be said to have laid the groundwork for future experimentalists to develop.

Pyroxylin,¹⁴ has usually been considered as a perfectly inert 1887, **1**, 352, 1888, **2**, 118, 1889, **3**, 401, 1890, **4**, 331, 1892, **6**, 386, 1896, **10**, 473, 1897, **11**, 169, 396, 1898, **12**, 104, 1902, **16**, 515, 1903, **17**, 517, 1904, **18**, 3, 478, 1905, **19**, 422, 1906, **20**, 142, 510, 1908, **22**, 191, 1909, **23**, 370, 1910, **24**, 486, 1912, **26**, 475, 1914, **28**, 75. Phot. Mitth. 1867, **3**, 86, 1868, **4**, 275, 1872, **8**, 117, 1873, **9**, 58, 79, 210, 275, 1876, **12**, 8, 10, 66, 86, 93, 180, 198, 240, 264, 270, 272, 276, 284, 287, 292, 301, 1880, **16**, 72, 73, 127, 180, 190, 208, 1882, **18**, 63, 1884, **20**, 3, 97, 1885, **21**, 190, 1889, **25**, 77, 149, 1890, **27**, 108, 1895, **31**, 78, 27. 1896, **33**, 344, 1905 • **42**, 120, 314, 1906, **43**, 308. Chem. Tech. Rep. 1865, **4**, 11, 672, 1872, **11**, 11, 147, 1878, **17**, 1, 337, 11, 165; 1887, **26**, I, 194. Poly. Centr. 1870, **36**, 850. Poly. Notizbl. 1854, **9**, 357. Mon. Phot. 1861 1965, **4**, 83. Jahr. Chem. 1888, **41**, 2904 1889, **42**, 2876, 2878. Bull. Soc. Franc. Phot. 1868, **14**, 134, 1872, **18**, 55, 117, 1874, **20**, 37, 89, 1875, **21**, 285, 1879, **25**, 172, 1881, **27**, 13, 124, 247, 1895, 129, **11**, 187. Brit. J. Phot. 1864, **11**, 201, 1871, **18**, 59, 83, 98, 335, 184, 1872, **19**, 102, 132, 557; 1873, **20**, 251, 1874, **21**, 203, 335, 1875, **22**, 87, 170, 201, 457, 1876, **23**, 166, 337, 406, 180, 1877, **24**, 13, 226, 371, 1878, **25**, 215, 251, 435, 1879, **26**, 227, 251, 568; 1880, **27**, 73, 285, 1883, **30**, 319, 351, 424, 1885, **32**, 385, 401, 1889, **36**, 661, 1890, **37**, 705, 817, 1892, **39**, 211, 227, 243, 1894, **41**, 171, 1897, **44**, 50, 772, 1905, **52**, 710, 1044. Phot. News, 1861, **5**, 181, 571, 1865, **9**, 337, 1872, **16**, 325, 334, 1873, **17**, 6, 285, 1877, **21**, 198, 373, 1879, **23**, 244, 1880, **24**, 366, 531, 1898, **42**, 647.

1. La Lumière, 1853, Aug. 20. Phot. News, 1861, **5**, 403, Phot. Notes, 1861, **6**, 156. See also La Lumière, 1861, Apr. 15.

2. Mon. Phot. 1861, Brit. J. Phot. 1861, Phot. News, 1860, **4**, 250. L'Invention, 1861. See also Phot. News, 1861, **5**, 181. Burnett, Brit. J. Phot. 1868, **15**, 520.

3. E. P. 1074, 1861.

4. Brit. J. Phot. 1864, **11**, 340, 359, 371, 374, 377, Phot. Mitth. 1864, **1**, 100, 1865, **2**, 61, Phot. News, 1865, **9**, 305, Phot. Korr. 1866, 333. Silver Sunbeam, 1866, 389, 1879, 575. J. Towler, Brit. J. Phot. 1905, **52**, 710. See also Sayce, Brit. J. Phot. 1864, **11**, 374, 377. M. Lea, Brit. J. Phot. 1874, **21**, 24, 133, 145, Phot. Mitth. 1875, **2**, 20. Lafollevé, Bull. Soc. Franc. Phot. 1879, **25**, 156.

5. Phot. Archiv., 1861, May 16. Mon. Phot. 1861, Brit. J. Phot. 1864, **11**, 377.

6. Brit. J. Phot. 1870, **21**, 312, 471.

7. Brit. J. Phot. 1870, **17**, 192, 1871, **18**, 275, 434, 1905, **52**, 248. See also Brit. J. Phot. 1871, **18**, 263, Phot. Mitth. 1873, **7**, 75, 127, 274. • M. Lea, Brit. J. Phot. 1875, **22**, 634.

8. Phot. News, 1874, **18**, 191, Brit. J. Phot. 1874, **21**, 490. See also Brit. J. Phot. 1875, **22**, 122, Bull. Soc. Franc. Phot. 1875, 133.

9. Amer. Inst. 1875, Bull. Soc. Franc. Phot. 1875, 276, 304, Phot. News, 1875, **19**, 344, 409, 557, 382.

10. Brit. J. Phot. 1874, **21**, 188, 201, 1876, **23**, 480.

11. Phot. News, 1872, **19**, Brit. J. Phot. 1872, **19**, 20, 417, 489, Phot. Mitth. 1872, **8**, 90. See M. Lea, Brit. J. Phot. 1875, **22**, 140. Newton, Brit. J. Phot. 1876, **23**, 123, 214.

12. Brit. J. Phot. 1875, **22**, 125. See also Anon., Brit. J. Phot. 1876, **23**, 176, 433.

13. Brit. J. Phot. 1877, **24**, 401.

14. See Brit. J. Phot. 1877, **24**, 62, 1880, **28**, 419, 1883, **30**, 289, 411, 1885, **32**, 357; Phot. News, 1872, **16**, 241, 1878, **22**, 570.

vehicle for silver salts, but R. Liesegang¹ contended this assumption was unwarranted, which seems also to have been the experience of König.² The question naturally arose as to the particular type of pyroxylin most suitable for emulsion purposes, and this angle of the subject has been studied and reported upon by "Amerateur,"³ J. Nicol,⁴ Hardwich,⁵ L. Warnecke,⁶ and by H. Wortley.⁷ Papyroxylin (nitrated paper) by R. Liesegang, A. Davanne and T. Sutton,⁸ was recommended; J. Gough⁹ added a few drops of glucose to the cotton before nitration; Bolton¹⁰ advised the use of nitroglucose alone; Pitteurs¹¹ mixed it with cotton. A. Chardon¹² used Mann's Russian cotton; Williams first employed collodion,¹³ while Fourier¹⁴ pointed out the value of standardizing the collodion by viscosity determinations.¹⁵

Process of Emulsification. There are practically three methods of emulsifying the sensitive salt, being:

- a. Precipitating from aqueous or alcoholic solution, and then emulsifying.¹⁶
- b. Dissolving the halides in collodion, allowing solvents to evaporate, then digesting in aqueous silver nitrate.¹⁷
- c. Addition of silver nitrate to bromized collodion, or a modification of this method.¹⁸

Emulsions composed primarily of chlorine as the silver halide

1. Photochemische Studien, 1894, 6.
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3. Phot. News, 1873, **18**, 285.
4. Brit. J. Phot. 1873, **20**, 507. See also Brit. J. Phot. 1875, **22**, 373.
5. Brit. J. Phot. 1875, **22**, 423, 446; 1876, **23**, 385; 1877, **24**, 229.
6. Bull. Belg. 1876, 73; Phot. Mitth. 1876, **12**, 301.
7. Yearbook Phot. 1876, 37.
8. Brit. J. Phot. 1878, **25**, 1.
9. Brit. J. Phot. 1874, **21**, 328.
10. Brit. J. Phot. 1874, **21**, 388.
11. Brit. J. Phot. 1878, **25**, 475, 467, 486; Phot. News, 1878, **22**, 502; Bull. Belg. 1879, 471.
12. Brit. J. Phot. 1879, **26**, 112, 231, 263.
13. Phot. News, 1879, **23**, 477.
14. Dict. Pract. Chim. Phot. 1892, 272.
15. "Die Collodium-Emulsion," 1894, 12. E. Vogel, Phot. Mitth. 1898, **34**, 203; Phot. Annual, 1898, 192; Phot. J. 1898, **22**, 236.
16. See Wilkinson, Photography, 1891, 466; Phot. Nachricht 1891, 638; Jahr. Phot. 1892, **6**, 286.
17. See Buyron, Bull. Soc. Franc. Phot. 1873, 312. M. Lea, Brit. J. Phot. 1875, **22**, 196; Phot. Mitth. 1875, **12**, 198; Phot. Korr. 1875, 201. Phips, Brit. J. Phot. 1874; Bull. Soc. Franc. Phot. 1874, 310. H. Wortley, Phot. News, 1876; Phot. Mitth. 1876, **13**, 137. Fabre, Phot. Korr. 1880, 215.
18. See W. Abney, Yearbook Phot. 1882, 152. See also Brit. J. Phot. 1867, **14**, 287. Phot. Mitth. 1872, **8**, 25, 81. Mou. Phot. 1867-1868, **7**, 93.

were developed by W. Davies,¹ H. Newton,² E. Smithells,³ W. Stillman,⁴ T. Sutton,⁵ E. Wallace,⁶ G. Wallich,⁷ and Wilde.⁸

Silver bromide formed the essence of the inventions and developments⁹ of E. Albert,¹⁰ E. Banks,¹¹ St. V. Beechey,¹² H. Berkeley,¹³ E. Boivin,¹⁴ W. Bolton,¹⁵ Brauner,¹⁶ J. Brier,¹⁷ Buyron,¹⁸ A. Chardon,¹⁹ Champion,²⁰ W. Coldwell,²¹ H. Cooper,²² A. Davanne,²³ L. Enjolras,²⁴ J. Gough,²⁵ Hommel,²⁶ Hornsey,²⁷ A. Johnson,²⁸ H. King,²⁹ M. Lea,³⁰ E. Lehmann and P. Knoche,³¹ P. Liesegang,³² H.

1. Brit. J. Phot. 1867, **14**, 301
2. Phot. Mitth. 1872, **9**, 8.
3. Mon. Phot. 1877, **16**, 64.
4. Brit. J. Phot. 1873, **20**, 416
5. Brit. J. Phot. 1871, **18**, 379.
6. Amer. J. Phot. 1886, **7**, 7
7. Phot. News, 1872, **16**, 130
8. Brit. J. Phot. 1880, **27**, 320
9. See Brit. J. Phot. 1864, **11**, 211, 373, 1866, **13**, No. 342, 1868, **15**, 229; 1871, **18**, 359, 457, 528, 529, 1872, **19**, 59, 71, 1875, **22**, 350, 1876, **23**, 97, 169; 1877, **24**, 194, 1878, **25**, 205, 223. Phot. News, 1872, **16**, 71, 88, 100; 1879, **23**, 244; 1880, **24**, 115, 543, 1884, **28**, 375, 1894, **38**, 175, 1898, **42**, 860. Amer. J. Phot. 1889, **10**, 165, Amer. Annual Phot. 191, 282. Phot. Annual, 1892, 65, 83, 1895, 166, 1898, 93, 192. Phot. Mitth. 1911, **48**, 332. Jahr. Chem. 1892, **45**, 2948
10. D. R. P. 237877; abst. C. A. 1912, **6**, 1890, J. S. C. I. 1911, **30**, 1410; Zts. ang. Chem. 1911, **24**, 1880; Wag. Jahr. 1911, **57**, 11, 507
11. Brit. J. Phot. 1883, **30**, 45
12. Brit. J. Phot. 1875, **22**, 469. Phot. News, 1871, **15**, 547.
13. Brit. J. Phot. 1877, **24**, 136.
14. Mon. Phot. 1877, **16**, 131.
15. Brit. J. Phot. 1874, **21**, 158, 201, 1877, **24**, 402, 1878, **25**, 423.
16. Mon. Phot. 1878, **17**, 102.
17. Phot. News, 1872, **16**, 80.
18. Phot. News, 1874, **45**, 41.
19. Brit. J. Phot. 1877, **24**, 206; Phot. News, 1877, **21**, 319
20. Phot. News, 1876, **20**, 77.
21. Can. P. 115378.
22. Phot. News, 1872, **16**, 77, 388, Brit. J. Phot. 1872, **19**, 71, 76
23. Phot. News, 1880, **24**, 165.
24. E. P. 7201, 1911; abst. J. S. C. I. 1911, **30**, 1139, C. A. 1912, **6**, 2582. F. P. 424900, 1910; abst. J. S. C. I. 1911, **30**, 924.
25. Brit. J. Phot. 1872, **19**, 26.
26. Brit. J. Phot. 1876, **23**, 308. For vacuum drying of plates and films, and the recovery of solvents from collodion see W. Hommel, D. R. P. 286933, 1914; abst. J. S. C. I. 1916, **35**, 199. F. Cossitt and L. Castor and the Ansco Co., U. S. P. 1171321, 1180255, 1916; abst. J. S. C. I. 1916, **35**, 386, 655, Ann. Rep. Soc. Chem. Ind. 1916, **1**, 301.
27. Phot. News, 1898, **42**, 647.
28. Brit. J. Phot. 1869, **16**, 518.
29. Phot. News, 1872, **16**, 119.
30. Phot. News, 1870, **14**, 260, 354, Brit. J. Phot. 1868, **15**, 14; 1870, **17**, 479; 1871, **18**, 350; 1875, **22**, 111, 196. Phot. Mitth. **7**, 75, 274.
31. Zts. Reprod. 1914, **16**, 8, 21; abst. C. A. 1914, **8**, 2318.
32. Mon. Phot. 1864-1865, **4**, 63.

Lüppo-Cramer,¹ Mathison,² D. v. Monckhoven,³ H. Newton,⁴ J. Nicol,⁵ Phipps,⁶ B. Sayce,⁷ E. Smithells,⁸ T. Sutton,⁹ J. Turnbull,¹⁰ H. Vogel,¹¹ F. Wilde,¹² J. Wolfram,¹³ W. Wood,¹⁴ H. Wortley,¹⁵ and Zettnow.¹⁶

A combination of the above in the use of chloro-bromide, or chlorides or bromides in other combinations together with silver nitrate constitute the essence of novelty in the inventions and disclosures of¹⁷ G. Dawson,¹⁸ H. Dixon,¹⁹ J. Fox,²⁰ G. Kemp,²¹ H. King,²² M. Lea,²³ R. Gordon,²⁴ J. Miles,²⁵ H. Newton,²⁶ E. Stebbing,²⁷ W. Stillman,²⁸ T. Sutton,²⁹ F. Turton,³⁰ S. Wollaston,³¹ and H. Wortley.³²

Ripening the Emulsion. The time required for ripening is

1. Kolloid Zts 1915, **17**, 105, 135, Chem Ztg Rep. 1916, **40**, 171, J. S. C. I 1916, **35**, 708
2. Sci Amer Suppl **6**, 2079
3. See T. Sutton, Brit J Phot 1871, **18**, 452
4. Brit J. Phot 1875, **22**, 271
5. Brit. J. Phot. 1877, **24**, 197
6. Phot News, 1874, **18**, 491
7. Brit J. Phot. 1863, **10**, 325, 375, 1864, **11**, 359, 377, 1865, **12**, 449.
8. Brit. J. Phot. 1876, **23**, 620
9. Brit J. Phot 1871, **18**, 85, 342, 571, 1872, **19**, 78
10. Phot News, 1867, **11**, 485
11. Phot Mitth **8**, 117
12. Phot News, 1877, **21**, 449
13. E. P. 847, 1880, abst Brit J. Phot 1880, **27**, 523 D. R. P. 12266, 1880, abst Chem Tech Rep 1881, **20**, I, 131.
14. Brit J. Phot. 1879, **26**, 242, Phot News, 1879, **23**, 244
15. Phot News, 1872, **16**, 329 Brit J. Phot 1871, **18**, 446, 1872, **19**, 164; 1873, **20**, 453 Phot Mitth **8**, 90
16. Brit J. Phot 1873, **20**, 14.
17. In this connection see Brit J. Phot 1871, **18**, 275, 280, 432, 539, 1872, **19**, 61, 367, 1875, **22**, 231, 293, 301, 581, 592, 1876, **23**, 68, 154, 1878, **25**, 180, 1883, **30**, 255 Phot News, 1872, **16**, 398, 471, 574, 1890, **34**, 16, 1898, **42**, 47 Mon Phot 1867-1868, **7**, 69
18. Brit J. Phot. 1870, **17**, 482
19. E. P. 1074, 1861.
20. Brit. J. Phot. 1871, **18**, 548
21. Brit. J. Phot. 1876, **23**, 502
22. Phot News, 1872, **16**, 538
23. Bull. Soc. Franc. Phot. 1875, 105, 131, 149 Brit J. Phot. 1866, **13**, 444; 1869, **16**, 624, 1870, **17**, 513, 1872, **19**, 2, 90, 121, 1874, **21**, July 10th, 133; 1875, **22**, 122, 147, 181, 590; 1876, **23**, 103. Phot News, 1875, **19**, 277.
24. Phot. News, 1872, **16**, 313
25. Brit J. Phot 1880, **27**, 124
26. Phot News, 1875, **19**, 557; 1876, **20**, 483.
27. Brit. J. Phot. 1877, **24**, 177.
28. Phot. News, 1872, **16**, 431.
29. Brit. J. Phot. 1872, **19**, 156.
30. Phot. News, 1872, **16**, 500.
31. Phot. News, 1872, **16**, 549, 561
32. Brit. J. Phot. 1871, **18**, 358, 372, 442. Phot News, 1872, **16**, 160, 161, 171, 403, 409, 467, 549.

dependent on the initial method of mixing the emulsion, i. e., whether the sensitive salt is formed in the presence of soluble bromide or with excess of silver nitrate, as developed by A. v. Hubl,¹ H. Norris,² David³ and H. Vogel.⁴

*Methods of Manufacture.*⁵ The details of preparation of collodion emulsions and especial *kinks* to be observed in order to obtain dependable results, are set forth in the writings and processes of F. Beach,⁶ St. V. Beechey,⁷ H. Berkeley,⁸ E. Boivin,⁹ W. Bolton,¹⁰ G. Brook,¹¹ W. Brooks,¹² H. Cooper,¹³ M. Crespon,¹⁴ G. Dawson,¹⁵ Fabre,¹⁶ H. Haakman,¹⁷ J. Henderson,¹⁸ Hornsey,¹⁹ A. Johnson,²⁰ J. Johnston,²¹ M. Lea,²² C. Lloyd,²³ O. Lohse,²⁴ A. Mackie,²⁵

1 "Die Collodium Emulsion," 1864, 23, Eder's Handb. Phot. 1866, 2, 379. See also M. Lea, Phot. Archiv 1868, 133, 1870, 11, 39.

2 E. P. 7044, 1888. Phot. Archiv 1889, 209. Phot. Korr 1889. Jahr Phot 1890, 4, 324. See also Jahr Chem 1889, 42, 2878, Chem. Cent., 1889, 60, 1, 127. Phot. Archiv 30, 219.

3 Bull. Soc. Franc. Phot. 19, 306. Bull. Assoc. Belge, 1903, 509. Jahr Phot 1894, 8, 383. Phot. Annual, 4, 69. Phot. J. 18, 115.

4 D. R. P. 12116, 13726, abstr. Wag. Jahr 1880, 26, 903. E. P. 2161, 1880, Zts. prakt. Phot. 1880, 2, 56. U. S. P. 235281.

5 For general details consult Brit. J. Phot. 1865, 12, 459, 1869, 16, 157, 1871, 18, 1, 174, 344, 1872, 19, 307, 453, 1874, 21, 14, 1875, 22, 503, 1876, 23, 7, 277, 469, 481, 508, 1877, 24, 67, 75, 136, 289, 301, 339, 386, 397, 1878, 25, 35, 48, 203, 285, 300, 1877, 26, 409, 551, 1878, 25, 607, 1879, 26, 249, 1880, 27, 160, 1882, 29, 470, 1883, 30, 305, 1885, 32, 616, 1891, 41, 806. Phot. News, 1872, 16, 331, 511, 1875, 19, 623, 628, 1876, 20, 31, 142, 261, 1878, 22, 130, 1880, 24, 534, 1881, 25, 170, 187, 1883, 27, 439, 1899, 43, 698. Bull. Soc. Franc. Phot. 1874, 20, 97, 1879, 25, 210. Phila. Phot. 1883, 20, 377. Phot. Archiv 1872, 13, 182, abstr. Chem. Centr. 1872, 43, 779.

6 Phot. News, 1889, 33, 1, 5, 91, 165.

7 Brit. J. Phot. 1876, 23, 237.

8 Brit. J. Phot. 1877, 24, 71, 93, 118, 340, 413, 1878, 25, 448.

9 Brit. J. Phot. 1877, 24, 306.

10 Phot. News, 1868, 12, 149. Brit. J. Phot. 1865, 12, 605, 1876, 23, 471, 1877, 24, 376.

11 Brit. J. Phot. 1872, 19, 34.

12 Phot. News, 1879, 23, 40.

13 Brit. J. Phot. 1871, 18, 289.

14 Phot. News, 1858, 1, 76.

15 Brit. J. Phot. 1869, 16, 253, 312.

16 Brit. J. Phot. 1878, 25, 448.

17 Phot. News, 1881, 25, 129.

18 Phot. News, 1869, 13, 212.

19 Phot. News, 1898, 42, 647.

20 Brit. J. Phot. 1869, 16, 308.

21 Brit. J. Phot. 1876, 23, 460.

22 Phot. News, 1868, 12, 533, 1870, 14, 440. Brit. J. Phot. 1868, 15, 96, 522, 1871, 18, 68, 272, 469, 1875, 22, 172, 1877, 24, 280.

23 Brit. J. Phot. 1880, 27, 328.

24 Phot. News, 1877, 21, 158.

25 Phot. News, 1897, 41, 271.

M. Magny,¹ A. Mathison,² J. Monsoht,³ J. Nesbit,⁴ H. Newton,⁵ J. Nicol,⁶ E. Phipps,⁷ J. Plener,⁸ G. Poiron,⁹ L. Rommelaere,¹⁰ B. Sayce,¹¹ S. Singer,¹² A. Smith,¹³ T. Sutton,¹⁴ H. Vogel,¹⁵ E. Wallace,¹⁶ G. Williams,¹⁷ W. Wilson,¹⁸ J. Wolfram,¹⁹ H. Wortley,²⁰ and Zettnow.²¹

Principal among the more meritorious of the methods,²² are the processes of M. Andra,²³ W. Bolton,²⁴ R. Brown,²⁵ A. Chardon,²⁶ E. Lacan,²⁷ M. Lea,²⁸ P. Liesegang,²⁹ E. Phipps,³⁰ T. Sutton,³¹ H. Vogel,³² L. Warnerke,³³ H. Wortley,³⁴ and Zipser.³⁵

1. Brit. J. Phot. 1879, **26**, 163.
2. Phot. News, 1878, **22**, 231.
3. Brit. J. Phot. 1879, **26**, 285.
4. Brit. J. Phot. 1884, **32**, 744. Phot. News, 1884, **28**, 743.
5. Phot. News, 1875, **19**, 364, 400. Bull. Soc. Franc. Phot. 1875, **21**, 275, 303.
6. Brit. J. Phot. 1879, **26**, 218.
7. Brit. J. Phot. 1866, **13**, 100. Phot. News, 1874, **18**, 536.
8. D. R. P. 20733, 1882.
9. Brit. J. Phot. 1884, **31**, 302.
10. Bull. Soc. Franc. Phot. 1879, **25**, 273.
11. Brit. J. Phot. 1863, **10**, 496.
12. Phot. News, 1875, **19**, 465. Brit. J. Phot. 1876, **23**, 558, 559.
13. Phot. News, 1890, **34**, 221.
14. Brit. J. Phot. 1871, **18**, 115, 312, 397; 1872, **19**, 75; 1873, **20**, 8; 1874, **21**, 271, 283.
15. Brit. J. Phot. 1880, **27**, 204; 1881, **28**, 402; 1882, **29**, 574. Bull. Soc. Franc. Phot. 1880, **26**, 74.
16. Phot. News, 1873, **18**, 219. Brit. J. Phot. 1873, **20**, 242.
17. Brit. J. Phot. 1879, **26**, 337, 373.
18. Phot. News, 1869, **13**, 175.
19. E. P. 847, 1880; abst. Phot. News, 1883, **27**, 170.
20. Brit. J. Phot. 1871, **18**, 276; 1873, **20**, 200; 1874, **21**, 20; 1875, **22**, 142. Phot. News, 1872, **16**, 190, 295.
21. Poly. Centr. 1872, **38**, 191. See also Phot. News, 1873, **18**, 167.
22. See Brit. J. Phot. 1873, **20**, 405; 1876, **23**, 61, 85; 1878, **25**, 56. Phot. News, 1872, **16**, 23, 292; 1878, **22**, 14, 503; 1881, **25**, 71; 1883, **27**, 378; 1897, **41**, 819. Yearbook Phot. 1878, 148. Bull. Soc. Franc. Phot. 1873, **19**, 22; 1876, **22**, 5, 109; 1879, **25**, 39, 119, 755; 1880, **26**, 275, 285. Jahr. Phot. 1895, **9**, 467; 1903, **17**, 517; 1910, **24**, 425.
23. Phot. News, 1877, **21**, 283; 1880, **24**, 341.
24. Brit. J. Phot. 1885, **32**, 567; 1888, **35**, 107. Phot. News, 1897, **41**, 175.
25. Brit. J. Phot. 1880, **27**, 131.
26. Phot. News, 1877, **21**, 235, 249.
27. Phot. News, 1877, **21**, 170, 247.
28. Bull. Soc. Franc. Phot. 1870, **16**, 124. Phot. News, 1875, **19**, 314.
29. Brit. J. Phot. 1864, **11**, 377.
30. Brit. J. Phot. 1874, **21**, 532.
31. Brit. J. Phot. 1872, **19**, 355.
32. Phot. News, 1881, **25**, 34. Bull. Soc. Franc. Phot. 1881, **27**, 81. E. P. 2132, 1880.
33. Phot. News, 1876, **20**, 85, 98; Brit. J. Phot. 1876, **23**, 349; Phot.

*Colloid Emulsion Manipulation.*¹ The methods of developing, fixing, intensifying, reducing, toning, etc., are fully set out in the directions of W. Abney,² C. Bardy,³ F. Beach,⁴ T. Biggs,⁵ W. Bolton,⁶ W. Brooks,⁷ A. Chardon,⁸ A. Davanne,⁹ G. Dawson,¹⁰ J. Eder and V. Toth,¹¹ A. Hubl,¹² A. Johnson,¹³ M. Lea,¹⁴ C. Lloyd,¹⁵ J. M'Kean,¹⁶ A. Mathison,¹⁷ Queval,¹⁸ W. Richmond,¹⁹ J. Salmon,²⁰ B. Sayce,²¹ R. Sedgfield,²² T. Sutton,²³ E. Vogel²⁴ and J. Wolfram.²⁵

Action of Acids and Oxidants on Colloid Emulsions. Where an emulsion is prepared with excess of silver nitrate, it is essential to add some substance which will prevent the formation of fog. Nitro-hydrochloric acid,²⁶ uranium nitrate,²⁷ cobalt nitrate,²⁸

Mith. 1876, **12**, 301.

34. Phot. News, 1872, **16**, 176, 231.

35. Phot. Mitth. 1877, **14**, 242.

1. In this connection see also Brit. J. Phot. 1867, **14**, 324, 1869, **16**, 514; 1875, **22**, 125, 149, 544, 1876, **23**, 292, 1877, **24**, 244, 1878, **25**, 1; 1880, **27**, 239; 1883, **30**, 69, 231; 1885, **32**, 190, 1892, **39**, 211. Phot. News, 1872, **16**, 89; 1877, **21**, 184, 1878, **22**, 405; 1892, **36**, 822. Phot. Annual, 1893, 90, 96, 98, 1894, 84; 1895, 175. Jahr. Phot. 1897, **11**, 309, 400, 1903, **17**, 519, 1908, **22**, 492, 493, 506, 507. Amat. Phot. 1893, **17**, 240. Brit. J. Alm. 1895, 646; 1914, 634.

2. Phot. Bull. 1879, **10**, 338.

3. Bull. Soc. Franc. Phot. 1879, **25**, 210, abst. Phot. Mitth. 1879, **16**, 177.

4. Brit. J. Phot. 1889, **36**, 75.

5. Brit. J. Phot. 1878, **25**, 218.

6. Brit. J. Phot. 1878, **25**, 436; 1888, **35**, 559, 1897, **44**, 21.

7. Brit. J. Phot. 1878, **25**, 219.

8. Brit. J. Phot. 1877, **24**, 218.

9. Brit. J. Phot. 1877, **24**, 557.

10. Brit. J. Phot. 1869, **16**, 300, 573.

11. Phot. News, 1876, **20**, 608, 1890, **34**, 68.

12. Phot. News, 1892, **36**, 809.

13. Brit. J. Phot. 1869, **16**, 541.

14. Phot. News, 1876, **20**, 284. Brit. J. Phot. 1868, **15**, 527, 1871, **18**, 217, 1876, **23**, 280.

15. Brit. J. Phot. 1883, **30**, 160.

16. Brit. J. Phot. 1882, **29**, 715.

17. Brit. J. Phot. 1873, **25**, 220.

18. Phot. News, 1879, **23**, 205.

19. Brit. J. Phot. 1879, **26**, 213.

20. Phot. News, 1879, **23**, 349.

21. Brit. J. Phot. 1888, **35**, 542.

22. Brit. J. Phot. 1872, **19**, 141.

23. Brit. J. Phot. 1871, **18**, 534.

24. Phot. Mitth. 1894, **31**, 165. Brit. J. Phot. 1881, **28**, 348, 1899, **46**, 96.

25. D. R. P. 12286; abst. Wag. Jahr. 1881, **27**, 904.

26. Eder, Handb. Phot. 1896, **2**, 385. M. Lea and H. Wortley, Brit. J. Phot. 1871, **18**, 90. Phot. Mitth. **8**, 90, 1871, 230. See also Gough, Brit. J. Phot. 1874, **21**, 329. L. Warnerke, Bull. Assoc. Belge, **4**, 35; Phot.

cupric bromide,¹ or tincture of iodine or bromine² being some of the materials advocated for this purpose.

Keeping Properties of Collodion Emulsions. All emulsions prepared with an excess of halide have apparently almost indefinite keeping qualities, whereas those produced with excess of silver salt or in the presence of ammonia tend to deteriorate and become foggy. The excess of silver nitrate in the mixture may be converted into chloride as suggested by M. Lea³ or by cobalt or calcium chlorides.⁴ S. Singer,⁵ and also A. Chardon⁶ formed either silver carbonate or cyanide.

Preservatives, Organifiers, Sensitizers. Those collodion emulsions prepared with excess of silver nitrate do not require preservatives, as the free silver salt acts efficiently, and the use of these organic sensitizers—in the main—may be said to be actually prejudicial, not only on the sensitiveness but also on the fog, as they decompose the silver nitrate with the formation of organic compounds of diminished stability. This point has been emphasized⁷ by B. Sayce,⁷ H. Wortley,⁸ H. Vogel,⁹ and L. Warnerke.¹⁰ A. v. Hubl suggested certain alkaloids,¹¹ quinidine, cinchonine, morphine, caffeine, papaverine, narceine, apomorphine, meconine, codeine, narcotine, either as the base or in the form of their acetates. Tannin was advocated by B. Sayce and W. Bolton¹² and by M. Lea,¹³ while pyrogallol,¹⁴ gallic acid,¹⁵ tannin and morphine,¹⁶ aesculin,¹⁷ sulfocarminic acid¹⁸ and urea were tried

Korr 1878, 235, Phot. Mitth 1878, **14**, 301

27 See Phot Mitth 1872, **9**, 41

28 M. Lea, Phot Mitth **10**, 120

1 W. Abney, Brit. J. Phot 1879, **26**, 603. „

2 See Eder, Handb. Phot 1896, **2**, 386

3. Phot. News, 1876, **20**, 382.

4 Phot News, 1875, **19**, 344, 409, 557, 628. Silver Sunbeam, 1879, 577

5 Phot Mitth **12**, 276

6 Phot. Korr. 1876, 36; 1877, 212.

7 Brit. J. Phot 1864, **11**, 377; Phot. News, 1865, **9**, 305

8 Brit. J. Phot 1876, **23**, 65

9 Phot Mitth 1879, **16**, 301

10 Bull. Assoc. Belge, 1877, **4**, 35, Phot. Korr 1878, 235

11 "Die Collodium-Emulsion," 1864, 36.

12 Brit. J. Phot. 1864, **11**, 377.

13 Brit. J. Phot. 1870, **23**, 19 Phot. Archiv 1871, 7.

14 W. Abney, Phot. News, 1879, **23**, 267.

15 M. Lea, Brit. J. Phot. 1870, **23**, 19.

16 E. Boivin, Brit. J. Phot. 1877, **30**, 315, 329.

17 A. Chardon, "Phot. par emulsions seche," 1877.

18 See Brit. J. Phot. 1870, **17**, 400.

by others.¹ Gelatine was proposed by R. Norris,² Banks,³ J. Monsoht⁴ and H. Wortley.⁵

Various coloring matters have been added, as alkanet root or caramel,⁶ ammoniated albumen,⁷ shellac in solution,⁸ ammoniac,⁹ guaiac.¹⁰ W. Abney,¹¹ Bollone,¹² and G. Dawson¹³ objected to resins on the ground that they indurated the film where it was not easily penetrated by the developer.

Gold chloride,¹⁴ acidulated uranium nitrate,¹⁵ silver malate,¹⁶ tincture of aloes,¹⁷ and alcoholic solution of white soap¹⁸ are some of the other materials which were suggested or used for this purpose.¹⁹

Sensitizing Leather and Fabrics. The use of a celluloid or collodion substratum for insulating a support from a sensitive

- 1 Brit J Phot 1871, **18**, 131
- 2 E. P. 1074, 1861 Phot Notes, 1861, **6**, 140, 156
- 3 Brit J Phot 1883, **39**, 132, 202, 236 Phot Woch 1883, 114, 151, 162
- 4 Brit J Alm 1880, 190
- 5 Brit J Phot 1877, **24**, 136
- 6 S. Singer, Phila Phot 1871 Phot Mitth 1876, **13**, 215
- 7 W. Abney, Brit J Phot 1877, **24**, 136, 294 Phot News, 1877, **21**, 175, 202 J. Nicol, Brit J Phot 1880, **27**, 51
- 8 M. Lea, Brit J Phot 1867, **14**, 140 Phot Archiv 1867, 378 Phot Mitth 1867, **11**, 21
- 9 W. Stillman, Phot Mitth 1877, **14**, 122
- 10 M. Lea, Brit J Phot 1867, **14**, 140
- 11 W. Abney, "Photography with emulsions," 1882, 85
- 12 Bollone, Bull Soc Franc Phot 1873, **19**, 205
- 13 G. Dawson, Brit J Phot 1869, **16**, 200
- 14 H. Newton, Phot News, 1878, **22**, 9
- 15 H. Wortley, Brit J Phot 1872, **19**, 50, 1873, **20**, 477, 489 Phot Archiv 1873, 116
- 16 H. Wortley, Brit J Phot 1872, **19**, 84 Phot Archiv 1873, 116
- 17 M. Lea, Brit J Phot 1867, **14**, 140, Phot Archiv 1867, 380
- 18 J. Fox, Brit J Phot 1875, **22**, 275, Brit J Alm 1875, 229
- 19 In this connection see P. Mawdsley, Phot News, 1876, **20**, 616 W. Abney, Phot News, 1877, **21**, 175 F. Beach, Brit J Phot 1889, **36**, 89 St. V. Beechy, Phot News, 1872, **16**, 260, Brit J Phot 1871, **18**, 353, 1872, **19**, 245 G. Brogden, Brit J Phot 1871, **18**, 300 H. Cooper, Brit J Phot 1872, **19**, 84 G. Dawson, Brit J Phot 1869, **16**, 549, 564 L. Enjolras, E. P. 7201, 1911 J. Fox, Brit J Phot 1874, **21**, 278, 297 J. Gough, Brit J Phot 1874, **21**, 328 J. Hutchinson, Brit J Phot 1871, **18**, 309 J. Plucker, Phot News, 1874, **18**, 208 S. Singer, Brit J Phot 1876, **23**, 461 W. Richmond, Brit J Phot 1879, **26**, 225 M. Tronquoy, Phot News, 1872, **16**, 527, 536 H. Wortley, Brit J Phot 1876, **23**, 101 H. Vogel, Phot News, 1876, **20**, 5 T. Sutton, Brit J Phot 1874, **21**, 73 M. Lea, Bull Soc Franc Phot 1875, **21**, 187, Brit J Phot 1868, **15**, 553, 1874, **21**, 170 H. Luppé-Cramer, Kolloid Zts 1915, 105, abst J. S. C. I 1916, **95**, 708; Ann. Rep. Soc. Chem. Ind. 1916, **1**, 391 Anon., Brit J Phot 1868, **15**, 13, No. 443; 1871, **18**, 597, 1876, **23**, 37, 1895, **42**, 647. Phot News, 1875, **19**, 442, 1878, **22**, 6 Photography, 1892, **4**, 684

emulsion has been repeatedly patented, and is found fully described in the processes of A. Cobenzl,¹ Farbwerke, vorm. M. L. & B.,² Neue Photographische Ges.,³ J. Hutinet and P. Lamy,⁴ H. Kuhn,⁵ Y. Schwartz⁶ and I. Hoffsummer.⁷

Collodion Positives. The earlier processes of A. Martin,⁸ J. Cutting,⁹ L. Angamarre,¹⁰ Navez,¹¹ Violin,¹² and P. de Lucenay,¹³ are now of but historical interest,¹⁴ the J. Mayall,¹⁵ Hannot,¹⁶ W. Bovey,¹⁷ A. Moitessseur,¹⁸ Biny,¹⁹ W. Brooks,²⁰ and G. Sternitzki,²¹ being more recent. The photographic paper of Thornton and Rothwell,²² the G. Pifer process for the direct production of positives,²³ the composite photograph method of J. Clive,²⁴ and the collodion process for preparing canvas for photographing of T. Fitzsimmons,²⁵ are representative of advancement.

In the formation of *alabastrine* positives, which is a development of the observation of F. Archer that the silver image could be rendered white by being treated with a solution of mercuric chloride,²⁶ we are indebted to the observations of E. Wallace²⁷

1. D. R. P. 102540, 1898.
2. E. P. 6769, 1898.
3. D. R. P. 154101.
4. E. P. 1538, 1881.
5. E. P. 6921, 1891.
6. D. R. P. 140008, 1902.
7. E. P. 3655, 1904.
8. Compt. rend. 1852, **35**, 29; Instit. 1852, 215; J. prakt. Chem. 1852, **57**, 249; Dingl. Poly. 1852, **125**, 119; Ann. 1853, **85**, 176; Chem. Centr. 1852, **23**, 713; Jahr. Chem. 1852, **5**, 219. See also Phot. News, 1859, **1**, 264. Brit. J. Phot. 1873, **20**, 603.
9. E. P. 1638, 1854; abst. J. Frankl. Inst. 1855; Amer. J. Pharm. 1855, **27**, 551.
10. E. P. 1159, 1856.
11. Instit. 1856, 192; abst. Jahr. Chem. 1856, **9**, 192.
12. Bull. Soc. Franc. Phot. 1857, **3**, 229.
13. E. P. 575, 1852.
14. See Poly. Centr. 1854, **20**, 1267.
15. E. P. 5080, 1887.
16. Phot. News, 1878, **22**, 304.
17. Phot. News, 1869, **13**, 147.
18. Phot. News, 1866, **10**, 316.
19. Phot. News, 1881, **25**, 478.
20. Brit. J. Phot. 1881, **28**, 251.
21. D. R. P. 110716, 1898; abst. Chem. Centr. 1900, **71**, II, 605.
22. U. S. P. 786536; E. P. 17738, 1899; abst. J. S. C. I. 1900, **19**, 689; 1906, **25**, 513.
23. E. P. 22735; 1905, abst. J. S. C. I. 1906, **25**, 609.
24. E. P. 2139, 1855.
25. U. S. P. 301706, 1884.
26. Brit. J. Phot. 1894, **41**, 50.
27. "The Amateur Photographer and Manual of Photographic Manipulation," 1884, 45, 77, 78.

and G. Simpson,¹ especially to the latter investigator.

The production of *ferrotypes*, *pannotypes*, *bon-tons*, *brotypes* or more often *tintypes*, as they were variously called,² represents the direct production of positive pictures by wet collodion, and was early exemplified in those curious semi-transparent portraits of our grandparents, with unusually rosy cheeks, which were mounted in a gilt case, leather backed frame, and erroneously known as *daguerreotypes*. In reality they are positive images taken direct from the subject, being unusually thin and under exposed negatives, in which the silver is precipitated in a grayish white condition, the black background being produced either by means of black velvet or by pouring a black varnish over the image—usually the former.

This process was developed as the result of the labors of H. Smith,³ R. Walz,⁴ A. Messer,⁵ H. Hedden,⁶ W. Heighway,⁷ and E. Wilson.⁸ Melainotype plates⁹ were similar. In all modifications, collodion was an essential ingredient.

In the so-called *opalotypes*, or pictures on opal glass or porcelain, there is a delicacy and transparency, combined with force and vigor, which caused this class of photographic impressions to be extensively experimented upon.¹⁰ The various phases of development of this process are indicated in the patented methods of A. Messer,¹¹ W. Hill,¹² E. Pettitt,¹³ H. Hedden,¹⁴ W. Picken,¹⁵

1. Phot. News, 1860, **3**, 245; Brit. J. Phot. 1860, **7**, 7.

2. See-Brit. J. Phot. 1874, **21**, 143. Phot. News, 1858, **1**, 81; 1870, **14**, 387; 1872, **26**, 553; 1877, **21**, 339; 1879, **23**, 603; 1897, **41**, 335, 867. Amat. Phot. 1902, **35**, 484; 1908, **47**, 117. Jahr Phot. 1902, **16**, 569; 1904, **18**, 481. Eder Handb. Phot. 1896, **2**, 353.

3. U. S. P. 14300, 1856.

4. Brit. J. Phot. 1871, **18**, 30.

5. U. S. P. 152147, 1874.

6. U. S. P. 174525, 1876.

7. Brit. J. Phot. 1881, **28**, 91, 156.

8. Phot. News, 1872, **16**, 485.

9. Brit. J. Phot. 1862, **9**, 202.

10. Phot. News, 1866, **10**, 165, 1867, **11**, 217, 1869, **13**, 302, 1870, **14**, 253; 1874, **18**, 469; 1875, **19**, 448; 1876, **20**, 353. Brit. J. Phot. 1865, **12**, 251, 326; 1866, **13**, 443, 450; 1868, **15**, 386, 460, 474; 1869, **16**, 230, 431; 1874, **21**, 251; 1876, **23**, 181, 380; 1878, **25**, 489; 1879, **26**, 144; 1884, **31**, 209, 225, 306; 1889, **36**, 773.

11. U. S. P. 152147, 1874.

12. U. S. P. 141351, 1873.

13. E. P. 72, 1865; abst. Brit. J. Phot. 1868, **15**, 172.

14. U. S. P. 174525, 1876. See also H. Hedden and C. Hill, Phot. News, 1876, **20**, 221.

15. E. P. 21698, 1906; abst. Brit. J. Phot. 1907, **54**, 830, Brit. Annual Phot. 1909, 625.

- D. Carvalho,¹ G. Pifer,² C. Archer,³ J. Mayall,⁴ W. McCraw,⁵ O. Evans⁶ and V. Griswold.⁷

Improvements and extensions of the above processes for opalotype photography have been made by G. Wood,⁸ M. Kripendorff,⁹ J. Tunny,¹⁰ M. Pokorsky Joravko,¹¹ E. Wilson,¹² F. Wenderoth,¹³ J. Lamson,¹⁴ W. Haddock,¹⁵ C. Waldack,¹⁶ Metalline Platten Ges.,¹⁷ C. Hearn,¹⁸ G. Simpson,¹⁹ R. Liesegang,²⁰ A. Chardon,²¹ D. Duncan,²² G. Martyn,²³ W. Brooks,²⁴ G. Schreiber,²⁵ and G. Ramsay.²⁶

The Wothlytype,²⁷ Toovtype,²⁸ emmolotype²⁹ and the eburneum process of Burgess,³⁰ are similar.

Nitroglucose, which has been referred to on pages 1854 and 2803, was at one time in favorable demand as nitroglucose paper, especially for enlargements of non-albumenized prints. Developed by D. v. Monckhoven,³¹ and modified by others,³² it, for

1. U. S. P. 255171; abst. Brit. J. Phot. 1882, **29**, 52.
2. E. P. 22735, 1905; abst. Brit. J. Phot. 1906, **53**, 455.
3. E. P. 7853, 1903; abst. J. S. C. I. 1903, **22**, 819.
4. E. P. 5080, 1887.
5. E. P. 1843, 1857.
6. U. S. P. 166922, 1875.
7. U. S. P. 53815, 1866. E. P. 3190, 1865. Phot. News, 1866, **10**, 500.
8. E. P. 13191, 1890; abst. Phot. News, 1890, **34**, 872.
9. Phot. News, 1872, **16**, 307.
10. Phot. News, 1865, **9**, 197.
11. Phot. News, 1875, **19**, 531; Brit. J. Phot. 1875, **22**, 389.
12. Phot. News, 1874, **18**, 337.
13. E. P. 2909, 1871. See also Brit. J. Phot. 1866, **13**, 188, 224.
14. Wilson's Phot. Mosaics, 1877, 52.
15. Bull. Soc. Franc. Phot. 1867, **13**, 22. Phot. News, 1866, **10**, 487.
16. Phot. News, 1863, **7**, 307.
17. Addition of April 16, 1902 to F. P. 310161, 1901, abst. J. S. C. I. 1903, **22**, 44.
18. Phot. News, 1874, **18**, 28.
19. Phot. News, 1865, **9**, 219. Brit. J. Phot. 1865, **12**, 244.
20. Brit. J. Phot. 1877, **34**, 41.
21. Brit. J. Phot. 1873, **20**, 97.
22. Phila. Phot.; abst. Brit. J. Phot. 1871, **18**, 87.
23. Brit. J. Phot. 1883, **30**, 415.
24. Brit. J. Phot. 1880, **27**, 184.
25. Brit. J. Phot. 1872, **19**, 101.
26. Brit. J. Phot. 1874, **21**, 285.
27. Brit. J. Phot. 1864, **11**, 457.
28. Brit. J. Phot. 1864, **11**, 469.
29. H. Park, Brit. J. Phot. 1868, **15**, 597.
30. See Eder's Handb. Phot. 1896, **2**, 349. Bull. Soc. Franc. Phot. 1865, **11**, 206.
31. Phot. News, 1860, **10**, 346, 368. Brit. J. Phot. 1868, **15**, 275.
32. See Brit. J. Phot. 1866, **13**, 117; 1867, **11**, 66; 1868, **15**, 48; 1890, **37**, 497.

a time, enjoyed considerable prestige, but soon fell into disuse.

In the Wothlytype and uranium printing by means of collodion, patented by J. Wothly (also spelled Wothlij),¹ and purchased in England by H. Wortley,² use was made of a double uranium ammonium nitrate in the place of silver nitrate. The process was carefully tried by R. Fowler,³ G. Simpson,⁴ E. Musgrave,⁵ M. Lea,⁶ J. Taylor,⁷ H. Cooper,⁸ A. Chardon,⁹ and others.¹⁰

*Collodio-chloride Paper.*¹¹ For many years collodio chloride

1. U. S. P. 49488, 1865. E. P. 2347, 1864 (for J. Wothlij, by H. Wortley and W. Vernon). F. P. 65551 1864, abstr. Brit. J. Phot. 1865, **12**, 97. Phot. News, 1866, **10**, 382. Chem. Tech. Rep. 1864, **3**, 11, 76.

2. See Brit. J. Phot. 1864, **11**, 392.

3. Brit. J. Phot. 1866, **13**, 401.

4. Brit. J. Phot. 1864, **11**, 4. A review of previous work in uranium printing.

5. Brit. J. Phot. 1864, **11**, 445, 446.

6. Brit. J. Phot. 1864, **11**, 483.

7. Brit. J. Phot. 1865, **12**, 186.

8. Brit. J. Phot. 1865, **12**, 85, 139.

9. Phot. News, 1873, **18**, 98.

10. See Brit. J. Phot. 1864, **11**, 374, 421, 462, 506, 1865, **12**, 92, 110, 144, 168; 1868, **15**, 439, Phot. News, 1865, **9**, 88, 89. J. Wothly, Bull. Soc. Franc. Phot. 1866, **12**, 301. Compt. rend. 1860, **51**, 237, Poly. Cent. 1861, **27**, 281.

11. The preparation and manipulation of printing-out collodion emulsion on paper or other supports is fully discussed by F. Archer, La Lumiere, Aug. 20, 1853, Phot. News, 1861, **5**, 403; Brit. J. Phot. 1865, **12**, 53. Forrest, Humphrey's Phot. J. **9**, 124, 141. Hagen, Bull. Soc. Franc. Phot. 1858, 41. J. Wothly, Kreutzer's Zts. Phot. **6**, 39; E. P. 2373, 1864, Silver Sunbeam, 1866, 367; Compt. rend. 1860, **51**, 558. Ost. Phot. Korr. 1865, 15, 49. R. Liesegang, Phot. Archiv. 1865, 46; Phot. Korr. 1865, 300, Phot. Archiv. 1866, 169. G. Simpson, Phot. News, 1864, **8**, 517, 553, 1865, **9**, 121. Britton, Silver Sunbeam, 1866, 400, Brit. J. Phot. 1865, **12**, 241, Phot. News, 1865, **9**, 249; Phot. Archiv. 1865, 137. Kuhn, Phot. Archiv. 1866, 55. H. Wortley, Phot. Archiv. 1868, 222. Obernetter, Phot. Korr. 1868, 47, abstr. Wag. Jahr. 1885, **31**, 1060; Phot. Mitth. 1893, **30**, 245. Labiedzinski, Jahr. Phot. 1893, **7**, 451. E. Valenta, Jahr. Phot. 1889, **3**, 417. J. Taylor, Phot. News, 1887, **31**, 142. Formulae for the preparation of printing-out emulsion have been published by Niederstadt, Jahr. Phot. 1880, **3**, 417; Year Book Phot. 1900, 268. Geldmacher, Jahr. Phot. 1888, **2**, 129, Year Book Phot. 1900, 268. Wall, Jahr. Phot. 1891, **5**, 281; Year Book Phot. 1900, 269. D. v. Monckhoven, Year Book Phot. 1900, 269. E. Valenta, Phot. Korr. 1895, 378, Das Atelier, 1896, 39; Year Book, 1900, 270. Belitzki, D. Phot. Ztg. 1895, 5, Jahr. Phot. 1895, **19**, 226; Year Book Phot. 1900, 271. Vollenbruch, D. Phot. Ztg. 1892, 166; Jahr. Phot. 1893, **17**, 449. Anon., D. Phot. Ztg. 1893, 78; Jahr. Phot. 1894, **8**, 422, 448, Brit. Phot. Ann. 1892, 85; Brit. J. Phot. 1891, **38**, 721, 738. Veress, Liesegang's Phot. Alm. 1892, 25; Jahr. Phot. 1895, **9**, 473. Moss, Brit. J. Phot. 1898, **45**, 503; Jahr. Phot. 1898, **12**, 434; Photography, 1897, **7**, 502. Bolton, Brit. J. Phot. 1897, **44**, 245; Jahr. Phot. 1898, **12**, 435. Hanneke, "Das Celloidinpapier," 1897, 49, 50, 83, 90. Cobenzl, Jahr. Phot. 1911, **25**, 119; Phot. Ind. 1913, 1809; cf. Jahr. Phot. 1914, **28**, 360; Brit. J. Phot. 1914, **61**, 645; Chem. Ztg. 1913, **27**, 837, 886, 957, 990. T. Sutton, Brit. J. Phot. 1900, **47**, 600; Phot. Chron. 1900, 560, Jahr. Phot. 1901, **15**, 660. E. Valenta, Phot. Korr. 1903, 32, Jahr. Phot. 1904, **18**, 87. L. Graf, U. S. P. 229694, 1880. In this connection see also Belitzki,

paper and collodio-chloride positives were almost exclusively employed in photographic work, and at the present time are used extensively in several branches of the art. Data in respect to

D. Phot. Ztg. 1895, 5; Jahr. Phot. 1895, **9**, 226. Wardrowsky, Phot. Mitth. 1904, 349, 380; Brit. J. Alm. 1906, 809. E. Valenta, Phot. Korr. 1895, **241**, 305, 331; Jahr. Phot. 1896, **10**, 242; Phot. Annual, 1896, 158. T. Sutton, Brit. J. Phot. 1900, **47**, 600; Phot. Chron. 1900, 560; Jahr. Phot. 1901, **15**, 600. Vollenbruch, D. Phot. Ztg. 1892, 166; Jahr. Phot. 1893, **7**, 448. Lainer, Phot. Korr. 1895, **13**, 23; Jahr. Phot. 1890, **8**, 207; Phot. J. 1894, **18**, 222; Phot. Annual, 1895, 165. Bentzen, Phot. Ind. 1905, 480; Brit. J. Alm. 1906, 810. Voight, Phot. Korr. 1894, 40, 95, 143; Phot. Ann. 1895, 192. Aarland, Phot. Rundschau, 1894, 103; Phot. Annual, 1895, 192. E. Zettnow, Chem. Centr. 1872, **43**, 25; Pogg. Ann. 1871, **144**, 310. Dambrowski, Amat. Phot. 1899, **13**, 56. Woodbury, Photography, 1898, **3**, 549, 562, 579; Phot. Times, 1895, 195. Littke, D. Phot. Ztg. 1895, 366; Jahr. Phot. 1896, **10**, 514. E. Valenta, Phot. Korr. 1895, 378; 1896, 87; Jahr. Phot. 1896, **10**, 502; Brit. J. Phot. 1896, **43**, 246; Int. Phot. Ann. 1895, **8**, 204; Phot. Korr. 1900, 319, 449; Jahr. Phot. 1900, **24**, 130; Phot. J. 1900, **25**, 149. F. Hrdiczka-Csiszar, D. R. P. 85121, 1895; abst. Ber. 1896, **29**, 377-R.

J. Meyer, D. R. P. 114868, 1899; abst. Chem. Centr. 1900, **71**, II, 1048, used silver phosphate dissolved in organic acids such as citric or phosphoric, in pyroxylin or gelatine. Silver phosphate had been used as early as 1839 by Fyfe, Edin. new Phil. J. 1839, 144; Dingl. Poly. 1839, **74**, 55. Cf. Lyte, Horn's Phot. J. 1856, **3**, 50; La Lumiere, 1856, 76; Kreutzer's Jahr. 1857, 58. The effect of the addition of a chromate to a phosphate emulsion has been studied by E. Valenta, Jahr. Phot. 1906, **20**, 150; Phot. Korr. 1905, 312; Brit. J. Alm. 1907, 774; Sixth Internat. Cong. Appl. Chem. 1906; abst. Brit. J. Phot. 1906, **53**, 466; Brit. J. Alm. 1907, 790; Jahr. Phot. 1906, **20**, 517; Phot. Korr. 1906, 253. Foucaut, Amat. Phot. 1905, 482.

For "baryta paper" see Atel. Phot. 1906, 2; Brit. J. Phot. 1907, **54**, 4; Brit. J. Alm. 1908, 642. This is also known as "Kreide Papier." Banks, Phot. News, 1898, **42**, 56. Phot. Woch. 1892, 121; Jahr. Phot. 1893, **8**, 452. R. Liesegang, Phot. Nachricht. 1893, 6; Jahr. Phot. 1894, **9**, 420. The keeping qualities of these papers are discussed by Lainer, Third Internat. Cong. Appl. Chem.; abst. Phot. Chem. 1899, **2**, 117; Jahr. Phot. 1894, **8**, 421; Phot. Korr. 1893, 364. For matt papers see E. Valenta, Phot. Korr. 1903, 32; Jahr. Phot. 1904, **18**, 87.

For further information the following journals may be consulted: Wag. Jahr. 1873, **19**, 356; 1885, **31**, 1069. Amat. Phot. 1891, **13**, 154; 1892, **16**, 127, 301; 1894, **19**, 97, 188; 1895, **22**, 123, 237, 422; 1896, **23**, 116, 180, 513, 541; 1899, **30**, 66; 1900, **32**, 186; 1903, **38**, 46; 1905, **42**, 17; 1906, **43**, 439; 1907, **46**, 230; 1909, **50**, 281. Photography, 1890, **2**, 485; 1895, **7**, 747; 1903, **16**, 53, 55. Bull. Soc. Franc. Phot. 1867, **13**, 186; 1883, **29**, 313; 1884, **30**, 130; 1892, **8**, 636; 1894, **10**, 518; 1899, **15**, 536. Brit. Phot. Annual, 1892, 84, 97; 1893, 100; 1894, 85, 88; 1895, 163, 165, 182; 1896, 160; 1897, 193; 1898, 100. Chem. Tech. Rep. 1866, **5**, II, 59; 1881, **20**, I, 132; 1882, **21**, I, 133. Jahr. Chem. 1892, **45**, 2940; 1895, **48**, 1361. Mon. Phot. 1865-1866, **5**, 15, 18, 44, 45, 118, 126, 139, 188; 1877, **16**, 191. Anthony's Phot. Annual 1896, **8**, 8. Jahr. Phot. 1887, **1**, 315; 1889, **3**, 133, 416; 1890, **4**, 335; 1891, **5**, 281, 512; 1892, **6**, 105, 386, 417, 470; 1893, **7**, 175, 213, 218, 448, 451, 458, 465, 469; 1894, **8**, 207, 419, 390, 406, 420; 1895, **9**, 473, 477; 1896, **10**, 202, 242, 497, 501, 502, 514, 520, 609; 1897, **11**, 25, 209, 394, 427, 429, 431; 1898, **12**, 429, 435; 1899, **13**, 563, 592, 625, 608; 1900, **14**, 609, 612, 693; 1901, **15**, 130, 600, 660, 662; 1903, **17**, 517, 530, 531, 533; 1904, **18**, 87, 482, 497; 1905, **19**, 436, 478; 1906, **20**, 520, 521; 1907, **21**, 503; 1908, **22**, 528; 1911, **25**, 119, 125, 628; 1914, **28**, 75. Phot. Rundschau, 1895, **9**, 147; Amat. Phot. 1895, **8**, 81. Amer. J. Phot. 1893, **14**, 236; 1895, **16**, 176. Phot. Mitth. 1867, **3**, 2, 26, 42,

the various refinements which have been put forward in the development and perfection of this method of photographic production are to be found in the writings of Aarland,¹ W. Abney,² R. Anthony,³ W. Ashman and R. Offord,⁴ Baden-Pritchard,⁵ T. Baker,⁶ Belitzki,⁷ Blain,⁸ W. Bolton,⁹ W. Britton,¹⁰ O. Buss,¹¹ A. Busch,¹² Carsault,¹³ Christensen,¹⁴ Clark,¹⁵ A. Cobenzl,¹⁶ E. Colby & Co.,¹⁷ A. de Constant,¹⁸ E. J. Wall,¹⁹ W. Cronenberg,²⁰ F. Hrdliczka-Csiszar,²¹ Dambrowski,²² P. Does,²³ J. Eder,²⁴ J. Eder and Pizzighelli,²⁵ J. Eder and E. Valenta,²⁶ Evans,²⁷ Fallowfield,²⁸

- 78, **4**, 53; 228, 289; 1899, **5**, 28, 195; 1870, **6**, 6, 69, 612; 1871, **7**, 280; 1873, **9**, 45, 56; 1881, **17**, 39, 163; 1882, **22**, 5; 1888, **24**, 89; 1890-1891, **27**, 92; 1891-1892, **28**, 373; 1893, **29**, 162, 260; 1894, **30**, 245, 329, 333; 1894, **30**, 340, 349, 380, 381; 1895, **31**, 96, 249; **32**, 144; 1896-1897, **33**, 32, 1897-1898, **34**, 34, 181; 1898-1899, **35**, 51, 160, 169; 1899, **36**, 205, 1900, **37**, 235, 1903, **40**, 144, 206, 1904, **41**, 110, 349, 380; 1907, **44**, 159. Photogazette, 1891, **1**, 28. At. Phot. 1902, **9**, 207. Phot. News, 1864, **8**, 517, 553, 1865, **9**, 71, 86, 131, 155; 1866, **10**, 554; 1867, **11**, 223, 380; 1868, **12**, 362; 1870, **14**, 603; 1872, **16**, 124; 1873, **17**, 20; 1875, **19**, 519; 1877, **21**, 573, 577; 1879, **23**, 435; 1886, **30**, 96, 625; 1887, **31**, 114, 142; 1892, **36**, 256, 476. Brit. J. Phot. 1865, **12**, 90; 1866, **13**, 20, 543, 588; 1867, **14**, 384, 441, 445; 1868, **15**, 473, 1871, **18**, 417, 1874, **21**, 317; 1877, **24**, 234; 1887, **34**, 819; 1892, **39**, 581, 627, 1895, **42**, 651; 1897, **44**, 635, 765; 1905, **52**, 185; 1907, **54**, 314.
1. Phot. Rundschau, 1894, **8**, 103.
 2. Phot. News, 1874, **18**, 152; 1881, **25**, 401. Brit. J. Phot. 1882, **29**, 263; 1885, **32**, 107.
 3. U.S. P. 559058, 1896.
 4. Phot. News, 1885, **29**, 52.
 5. Phot. Mitth. **7**, 313, Bull. Soc. Franc. Phot. 1871, **17**, 48. Phot. News, 1870, **14**, 605.
 6. Amat. Phot. 1909, **50**, 281.
 7. Phot. Ztg. 1895, **19**, 11. See also Chem. Tech. Rep. 1863, **2**, I, 78.
 8. Bull. Soc. Franc. Phot. 1888, (2), **4**, 150.
 9. Brit. J. Phot. 1892, **39**, 404.
 10. Phot. News, 1865, **9**, 563.
 11. E. P. 22040, 1901.
 12. Chem. Ind. 1893, **16**, 444, Phot. Times, 1893, **23**, 526; Chem. Tech. Rep. 1893, **32**, II, 234.
 13. Bull. Soc. Franc. Phot. 1895, (2), **11**, 247.
 14. Phot. Mitth. 1890, **27**, 243, 323; 1891, **28**, 208; 1896, **33**, 298.
 15. Chem. Tech. Rep. 1892, **31**, I, 193.
 16. Brit. J. Phot. 1913, **60**, 705; abst. J. S. C. I. 1914, **33**, 1710.
 17. D. R. P. 82760; abst. Chem. Tech. Rep. 1895, **34**, II, 221.
 18. Phot. News, 1899, **13**, 342; Chem. Tech. Rep. 1899, **8**, II, 85.
 19. Jahr. Phot. 1891, **8**, 281. Wilson's Phot. Mag. Aug. 2, 1890. Jahr. Chem. 1892, **45**, 2040.
 20. Jahr. Phot. 1887, **1**, 117; 1888, **2**, 160.
 21. U. S. P. 574059, 1896.
 22. Amat. Phot. 1899, **13**, 56.
 23. Jahr. Phot. 1893, **7**, 175.
 24. Phot. News, 1886, **30**, 490; Chem. Tech. Rep. 1889, **28**, I, 158.
 25. Phot. News, 1882, **26**, 45. Brit. J. Phot. 1881, **28**, 558.
 26. Chem. Ind. 1899, **22**, 197.
 27. Phot. News, 1898, **42**, 414.
 28. Photography, 1892, **4**, 256.

Fitch,¹ Fleck,² R. Fowler,³ A. Freund,⁴ Frew,⁵ Gaedicke,⁶ M. Geymet,⁷ F. Geldmacher,⁸ S. Geoffray,⁹ Gilbert,¹⁰ L. Graf,¹¹ H. Gunther,¹² C. Haack,¹³ P. Hannecke,¹⁴ W. Harrison,¹⁵ J. Harvey,¹⁶ Herzheim,¹⁷ J. Hubert,¹⁸ J. Iggles,¹⁹ Jacob,²⁰ A. Jarman,²¹ H. Klepp,²² Knauer,²³ Krippendorf,²⁴ Krugener,²⁵ J. Kruger,²⁶ A. Kurtz,²⁷ F. Lambert,²⁸ A. Lainer,²⁹ Laisnier,³⁰ Lebedzinski,³¹ Ley,³² Liebert,³³ E. Liesegang,³⁴ P. Loescher,³⁵ O. Lortzing,³⁶ Lucke,³⁷ Lumiere,³⁸

1. Photography, 1890, **2**, 220.
2. Jahr. Phot. 1903, **17**, 530.
3. Brit. J. Phot. 1870, **17**, 8.
4. Phot. Corr. 1867, 176; Chem. Tech. Rep. 1867, **6**, 11, 89.
5. Bull. Soc. Franc. Phot. 1865, **11**, 244.
6. Phot. Mitth. 1893, **29**, 282, 296.
7. Phot. News, 1875, **19**, 378.
8. Phot. Mitth. 1886, **22**, 259, 276, 313. Brit. J. Phot. 1886, **33**, 83.
9. D. Phot. Ztg. 1885, 46. Jahr. Phot. 1888, **2**, 201.
10. Bull. Soc. Franc. Phot. 1856, **2**, 145.
11. Phot. Archiv. 1890, 173; abst. Chem. Tech. Rep. 1890, **29**, I, 182.
12. U. S. P. 220435; abst. Brit. J. Phot. 1880, **27**, 381. U. S. P. 229694, 1880.
13. Phot. News, 1892, **36**, 252.
14. Phot. News, 1869, **13**, 221.
15. Brit. J. Phot. 1897, **44**, 391; 1898, **45**, 633. Phot. Mitth. 1893, **29**, 336, 346; 1896, **33**, 250, 251, 260, 318, 330, 1901, **38**, 15. See also Henocque, Bull. Soc. Franc. Phot. 1883, **29**, 70.
16. Bull. Soc. Franc. Phot. 1867, **13**, 237.
17. Brit. J. Phot. 1895, **42**, 378.
18. Phot. Mitth. 1896, **33**, 33, 344, 379.
19. Brit. J. Phot. 1887, **34**, 119. Phot. News, 1887, **31**, 123.
20. Phot. News, 1889, **33**, 840.
21. Photography, 1892, **4**, 220.
22. Wilson's Phot. Mag. 1906, **43**, 218. Phot. News, 1902, **46**, 663.
23. Phot. Mitth. 1895, **31**, 249.
24. Brit. J. Phot. 1897, **44**, 773.
25. Phot. Archiv. 1870, 94; Poly. Notizbl. 1870, **25**, 331; Phot. Mitth. 1873, **9**, 147; Chem. Tech. Rep. 1873, **12**, I, 126. Phot. News, 1870, **14**, 318.
26. Phot. Mitth. 1894, **30**, 286, 293, 367.
27. Phot. News, 1872, **16**, 343, 496.
28. Phot. Mitth. 1890, **27**, 62, 138; 1894, **30**, 331, 345. Jahr. Phot. 1892, **6**, 417.
29. Amat. Phot. 1909, **49**, 324.
30. Phot. Mitth. 1897, **34**, 162. Jahr. Phot. 1894, **8**, 207. Phot. Corr. **37**, 353.
31. Bull. Soc. Franc. Phot. 1896, (2), **12**, 228.
32. Phot. Mitth. 1893, **29**, 394. Jahr. Phot. 1891, **5**, 509.
33. Brit. J. Phot. 1896, **43**, 773.
34. Bull. Soc. Franc. Phot. 1896, (2), **12**, 527. Phot. Mitth. 1894, **30**, 359.
35. Phot. News, 1883, **27**, 772; 1892, **36**, 683. Brit. J. Phot. 1883, **30**, 622. Phot. Mitth. 1887, **23**, 18. Amat. Phot. 1895, **22**, 436. See also Poly. Notizbl. 1866, No. 18; Phot. Archiv. 1866, 281; Poly. Centr. 1866, **32**, 1564; Dingl. Poly. 1866, **182**, 151; Chem. Tech. Mitth. 1866-1867, 30. Mon. Phot. 1867-1868, **7**, 21.
36. Phot. Mitth. 1896, **33**, 298.
37. D. R. P. 109839; abst. Jahr. Chem. 1900, **53**, 847.

F. Maxwell Lyte,¹ H. MacLean,² Macwalter,³ Maes,⁴ Mercer,^{5*} D. v. Monckhoven,⁶ G. Moss,⁷ R. Namias,⁸ Newton,⁹ Obernetter,¹⁰ A. Ost,¹¹ Perrot de Chaumeux,¹² Photochemischefabrik R Risse,¹³ Pizzighelli,¹⁴ Poulenc Bros.,¹⁵ Raltmanner,¹⁶ Riesenfeld,¹⁷ P. Rolier,¹⁸ C. Sans,¹⁹ Chem. Fabrik Act. vorm. E. Schering,²⁰ L. Schrank,²¹ Schutze and Noack,²² T. Sutton,²³ V. Schwartz,²⁴ G. Simpson,²⁵ Spangenberg & Co.,²⁶ J. Standigl,²⁷ C. Sutton,²⁸ W. Terry,²⁹ H. Thompson,³⁰ Trapp and Munch,³¹ E. Vogel,³² Voight,³³

37. Phot. News, 1866, **10**, 518.
38. Bull. Soc. Franc. Phot. 1905, 520, Brit. J. Phot. 1905, **52**, 1008, Brit. J. Alm. 1907, 774.
1. Brit. J. Phot. 1866, **14**, 110.
2. Phot. Mitth. 1866-1897, **33**, 48.
3. Brit. J. Phot. 1905, **52**, 330.
4. Phot. Mitth. 1893, **23**, 321.
5. Phot. News, 1877, **21**, 341.
6. Phot. Mitth. 1870, **6**, 212, Phot. News, 1869, **13**, 532, Chem. Tech. Rep. 1869, **8**, 11, 84.
7. Brit. J. Phot. 1895, **42**, 503, Phot. News, 1895, **39**, 517.
8. Phot. Mitth. 1903, **40**, 274.
9. Phot. Mitth. 1869, **8**, 73, Chem. Tech. Rep. 1872, **11**, 1, 109.
10. Phot. Mitth. 1868, **4**, 266, 300, 1877, **13**, 183, 1887, **23**, 224, 1882, **21**, 1, 133.
11. Brit. J. Phot. 1869, **16**, 166, Phot. News, 1869, **13**, 149, Chem. Tech. Rep. 1868, **7**, 11, 98, 99.
12. Bull. Soc. Franc. Phot. 1888, (2), **4**, 150.
13. E. P. 363086, 1906; abst. J. S. C. I. 1906, **25**, 867. Paper sensitized by the action of acids or salts, forming sensitive hydro- or nitrocellulose.
14. Phot. Corr. 1896, **33**, 310.
15. Mon. Phot. 1899, 366, Jahr. Phot. u. reproductionstechnik, 1900, 612. Their "matte" copying paper is known as "Taixe."
16. Jahr. Phot. 1890, **4**, 335.
17. Phot. Mitth. 1890-1891, **27**, 92.
18. E. P. 7766, 1905; abst. J. S. C. I. 1906, **25**, 493.
19. Phot. News, 1873, **17**, 141.
20. D. R. P. 149211, 1902. Phot. Mitth. 1896, **33**, 298, 379, 1897, **34**, 15.
21. See also Colby & Co., D. R. P. 82760, 1895. R. Krugener, D. R. P. 85359, 1895.
22. Phot. News, 1868, **12**, 476.
23. Phot. Mitth. 1890, **27**, 290, 304, 323; 1891, **28**, 113.
24. Brit. J. Phot. 1871, **18**, 362. Phot. News, 1865, **9**, 158.
25. U. S. P. 710019, 1902. E. P. 320451, 1902. E. P. 9993, 1902; abst. J. S. C. I. 1903, **22**, 44, 440. Jahr. Phot. 1904, **18**, 482, D. R. P. 140908, 1902.
26. Phot. News, 1865, **9**, 121; Brit. J. Phot. 1865, **12**, 137. Mon. Phot. 1865-1866, **5**, 10. Bull. Soc. Franc. Phot. 1866, **12**, 26, 1868, **14**, 262, 290. Phot. Mitth. 1895, **31**, 222. Chem. Tech. Rep. 1864, **3**, 11, 76.
27. Phot. Mitth. 1890, **27**, 257.
28. Phot. Mitth. 1896-1897, **33**, 344.
29. Brit. J. Phot. 1900, **47**, 593, Sci. Amer. Suppl. 1900, **50**, 20808, J. Phot. 1900, **47**, 599.
30. Phot. News, 1868, **12**, 224.
31. Brit. J. Phot. 1874, **21**, 309.
32. Phot. Mitth. 1891, **30**, 293, 1895, **31**, 129. Brit. J. Phot. 1903,

*Vollenbruch,¹ F. Wilde and Gorlitz,² G. Williams,³ W. Woodbury,⁴ and E. Zettnow.⁵

In those methods of photography which depend upon *silver phosphate emulsions*,⁶ the methods and disclosures of W. Hagelberg,⁷ Y. Schwartz,⁸ and E. Valenta⁹ should be consulted.

In *collodio-chloride bromide print outs* (bromide P. O. P.) the methods of E. Wall¹⁰ and Schultz-Sellack¹¹ are illustrative. In *self-toning collodio-chloride positives*,¹² the principle methods evolved are those of D. Bachrach,¹³ M. Bauer,¹⁴ C. Durand,¹⁵ P. Hanneke,¹⁶ J. Kolby,¹⁷ H. Lüttke,¹⁸ L. Marten,¹⁹ O. Steudel,²⁰ O. Raethel,²¹ and P. Schoenfelder and E. Kehle.²²

In *collodio-chloride gold toning*,²³ either with gold chloride

50, 302. Jahr. Phot. u. Reprod. 1900, 611. Phot. Mitth. 1895, **31**, 38; **32**, 257; 1903, **40**, 144. Phot. Korr. **40**, 230. See also Phot. Korr. 1895, **32**, 183.

32. Phot. Mitth. 1896-1897, **33**, 344; 1900, **37**, 157.

33. Phot. Mitth. **5**, 26.

1. Chem. Tech. Rep. 1893, **32**, II, 233; Jahr. Phot. 1893, **7**, 448. Brit. J. Phot. 1897, **44**, 436.

2. Jahr. Phot. u. Reprod. 1900, 609.

3. Brit. J. Phot. Sept. 1, 1865.

4. Phot. News, 1886, **30**, 629.

5. Pogg. Ann. 1871, **144**, 310; abst. Chem. Centr. 1872, **43**, 25. Phot. Mitth. 1872, **8**, 246.

6. See Brit. J. Phot. 1900, **47**, 700. Jahr. Phot. 1901, **15**, 130.

7. U. S. P. 428483, 1890.

8. U. S. P. 710019, 962788, 1910; F. P. 378305; abst. J. S. C. I. 1907, **26**, 1109.

9. Phot. Corr. 1900, **37**, 313, 449. Phot. Mitth. 1900, **37**, 201, 233. Jahr. Phot. 1906, **20**, 150. Brit. J. Phot. 1905, **52**, 588; 1906, **53**, 846. See also Brit. J. Phot. 1900, **47**, 325.

10. See E. Valenta, Phot. Korr.; abst. Phot. News, 1906, **50**, 473; 1907, **52**, 31.

11. Phot. Mitth.; abst. Phot. News, 1875, **19**, 103.

12. See Standage, Phot. News, 1891, **35**, 773; Jahr. Phot. 1892, **6**, 417. Jahr. Phot. 1895, **9**, 476; 1900, **14**, 612; 1901, **15**, 662. Amat. Phot. 1899, **37**, Apollo, 1899, 75. Phot. Mitth. 1907, **44**, 543.

13. Brit. J. Phot. 1897, **44**, 133.

14. E. P. 28284, 1902.

15. Phot. News, 1889, **13**, 415.

16. Phot. Mitth. 1904, **41**, 104.

17. D. R. P. 77162, 1893.

18. E. P. 17950, 1901; abst. J. S. C. I. 1902, **21**, 425.

19. U. S. P. 439021, 1890.

20. E. P. 10051, 1906; abst. Brit. J. Phot. 1906, **53**, 894.

21. E. P. 19683, 1899. Phot. Rundschau, 1899, **13**, 66. Brit. J. Phot. 1900, **47**, 829. D. R. P. 110089, 1897; abst. Jahr. Phot. Reprod. 1900, 612.

22. E. P. 6651, 1896; abst. Brit. J. Phot. 1896, **43**, 393. E. P. 15852, 896.

23. See Brit. J. Phot. 1869, **16**, 187; 1895, **42**, 746; 1897, **44**, 613. Phot. Rundschau, 1899, **13**, 192. Phot. News, 1897, **41**, 188. Phot. Annual, 1894, **6**; 1896, 160; 1897, 192, 194; 1898, 212. Phot. Mitth. 1894, **30**, 45, 129,

alone or in conjunction with cadmium chloride, the indicative methods are those of Obernetter,¹ C. Abt,² Blanc,³ E. Buhler,⁴ R. Chute,⁵ J. Gaedicke,⁶ Hrdliczka,⁷ P. Hanneke,⁸ H. Hernice,⁹ G. Hooper,¹⁰ Lainer,¹¹ Liesegang,¹² H. Maclean,¹³ C. Macnamara,¹⁴ Miethe,¹⁵ F. Novak,¹⁶ E. Olbrich,¹⁷ Paget Prize Plate Co.,¹⁸ J. Peter,¹⁹ F. Formatecher,²⁰ G. Simpson,²¹ Tzarn,²² E. Valenta,²³ W. Woodbury,²⁴ and C. Woodman.²⁵

In the combined toning and fixing of positives,²⁶ full directions are contained in the writings of J. Fallowfield,²⁷ F. Formstecher,²⁸ M. Geymet,²⁹ P. Hanneke,³⁰ A. Lainer,³¹ A. Londe,³² A. Kurtz,³³ A. Parzer-Mühlbacher,³⁴ J. Towler,³⁵ E. Valenta,³⁶ and E. 274, 275; 1895, **32**, 191; 1896, **33**, 31, 225, 397; 1898, **35**, 199; 1901, **38**, 127; 1902, **39**, 355; 1903, **40**, 303, 1905, **42**, 75, 118, 313, 1907, **44**, 231. *Jahr. Phot.* 1894, **8**, 6; 1901, **15**, 98, 663, 665. *Amat. Phot.* 1903, **38**, 126, 246.

1. *Brit. J. Phot.* 1868, **15**, 164, 527; 1869, **16**, 192.
2. *Phot. Mitth.* 1909, **46**, 62.
3. *Jahr. Phot.* 1897, **11**, 432.
4. *Jahr. Phot.* 1893, **7**, 218.
5. *Phot. Times*, 1875, **5**, 87.
6. *Phot. Mitth.* 1893, 202; 1894, 132, 202, 245.
7. *Bull. Soc. Franc. Phot.* 1897, (2), **13**, 263.
8. *Phot. Mitth.* 1895, **32**, 105. See also *Brit. J. Phot.* 1898, **15**, 234.
9. *Brit. J. Phot.* 1899, **46**, 311.
10. *Phot. News*, 1874, **18**, 254.
11. *Brit. J. Phot.* 1896, **43**, 789. *Phot. Corr.* 1896, **33**, 190, 213, 523.
12. *Bull. Soc. Franc. Phot.* 1897, (2), **13**, 184.
13. *Phot. Times*, 1884, **14**, 25.
14. *Bull. Soc. Franc. Phot.* 1896, (2), **12**, 39.
15. *Amat. Phot.* 1913, **58**, 544.
16. *Photogazette*, 1891, **1**, 28; 1892, **2**, 16.
17. *Brit. J. Phot.* 1902, **49**, 63; abstr. *J. S. C. I.* 1902, **21**, 276.
18. *Phot. News*, 1892, **36**, 730.
19. *Brit. J. Phot.* 1903, **50**, 491. See also *Brit. J. Phot.* 1896, **43**, 15.
20. *Phot. Mitth.* 1908, **45**, 136, 566.
21. *Brit. J. Phot.* 1895, **42**, 58.
22. *Bull. Soc. Franc. Phot.* 1865, **11**, 151. *Wiesch's Gewerbeztg.* 1868, 310.
23. *Phot. Mitth.* 1897, **34**, 251.
24. *Bull. Soc. Franc. Phot.* 1889, (2), **5**, 142.
25. *Phot. Corr.* 1902, **39**, 650; *Phot. J.* 1902, **42**, 236; abstr. *J. S. C. I.* 1903, **22**, 44. See also *Jahr. Phot. Reprod.* 1895, 477.
26. *Phot. News*, 1888, **30**, 741.
27. *Wilson's Phot. Mosaics*, 1879, 59.
28. See *Phot. Mitth.* 1890-1891, **27**, 138; 1894, **30**, 348, 1897, **34**, 231; 1900, **37**, 248; 1902, **39**, 29. *Jahr. Phot.* 1914, **28**, 353. *Amat. Phot.* 1901, **33**, 66. *Phot. Centr.* 1897, **3**, 147.
29. *Brit. J. Phot.* 1892, **39**, 219.
30. *Brit. J. Phot.* 1911, **58**, 457.
31. *Brit. J. Phot.* 1867, **14**, 352.
32. *Phot. Mitth.* 1897-1898, **34**, 94.
33. *Phot. Corr.* 1896, **33**, 23.
34. *Bull. Soc. Franc. Phot.* 1894, 579 (Dec. 7, 1894).
35. *Phot. Mitth.* 1890-1891, **27**, 138.
36. *Phot. Mitth.* 1900, **37**, 248.

Vogel.¹ In toning with platinum, on the other hand,² where potassium platinochloride is used either alone or in conjunction with gold salts, heavy and black tones are readily obtainable. The methods used in the working of this process are to be found in the directions as laid down by J. Bartlett,³ W. Brigham,⁴ J. Brown,⁵ H. Gunther,⁶ P. Hanneke,⁷ Kricheldorf,⁸ A. Lainer,⁹ P. Lebieczinski,¹⁰ H. Maclean,¹¹ R. Quednau,¹² Rhenanus,¹³ and E. Valenta.¹⁴

In *collodio-chloride developing*,¹⁵ pyrogallol, gallic acid, amidol, hydroquinone, pyrocatechin, are among those more frequently employed, details of the use of which are contained in the directions as published by J. Obernetter,¹⁶ P. Lebieczinski,¹⁷ Herzheim,¹⁸ Dehos and Deslandres,¹⁹ A. Bell,²⁰ E. Farmer and H. Tompkins,²¹ P. Hanneke,²² Liesegang,²³ C. Sans, E. Valenta,²⁴ and O. Wolfes.²⁵

35. Brit. J. Phot. 1868, **15**, 51.
36. Jahr. Phot. 1894, **8**, 206; Meyer Jahr. Chem. 1893, **3**, 545.
1. Phot. Mitth. 1901, **38**, 1, 290.
2. See Brit. J. Phot. 1909, **56**, 642. Brit. J. Phot. 1902, **49**, 101; abst. J. S. C. I. 1902, **21**, 365. Phot. News, 1895, **39**, 251. Mon. Phot. 1866, **6**, 151. Amat. Phot. 1903, **38**, 297. Phot. Annual, 1897, 194. Phot. Mitth. 1895, **32**, 191; 1898, **35**, 57, 185; 1899, **36**, 279, 280; 1900, **37**, 314; 1901, **38**, 259; 1903, **40**, 302; 1908, **45**, 139. Phot. Rundschau, 1896, **10**, 317. Jahr. Phot. 1895, **9**, 477, 483; 1896, **10**, 197, 238, 398, 428, 429, 1904, **18**, 498; 1911, **25**, 518.
3. Phot. Mitth. 1898, **35**, 150.
4. Brit. J. Phot. 1908, **55**, 20.
5. Phot. News, 1892, **36**, 132.
6. Phot. News, 1892, **36**, 138.
7. Phot. Mitth. 1896, **33**, 4, 181; 1897, **34**, 74.
8. Phot. Mitth. 1894, **30**, 46.
9. Brit. J. Phot. 1897, **44**, 55. Phot. Corr. 1897, **34**, 31, 162.
10. Phot. News, 1893, **37**, 179.
11. Phot. News, 1895, **39**, 388. See also Brit. J. Phot. 1907, **54**, 56.
12. Phot. Mitth. 1893, **30**, 171.
13. Phot. Rundschau, 1896, **10**, 138.
14. Phot. Corr. 1894, **31**, 232; Phot. Mitth. 1895, **31**, 38, 206. Brit. J. Phot. 1902, **49**, 101.
15. Brit. J. Phot. 1897, **44**, 610. Phot. News, 1898, **42**, 860. Phot. Mitth. 1894, **30**, 263; 1897, **34**, 115; 1898, **35**, 201; 1899, **36**, 231, 253, 1903, **40**, 303; 1905, **42**, 13, 347. Jahr. Phot. 1893, **7**, 53; 1894, **8**, 385; 1895, **9**, 479, 1904, **18**, 493; 1908, **22**, 529. Phot. Annual, 1893, 106, 109, 110; 1894, 90.
16. Brit. J. Phot. 1868, **15**, 510. See H. Vogel, Phot. Mitth. 1893, **30**, 245; abst. Jahr. Phot. 1894, **8**, 385.
17. See Jahr. Phot. 1893, **7**, 469.
18. Phot. Corr. 1892; abst. Meyer Jahr. Chem. 1893, **3**, 544.
19. Jahr. Phot. 1894, **8**, 426; Meyer Jahr. Chem. 1893, **3**, 545.
20. Phot. Mitth. 1899, **36**, 231.
21. Phot. News, 1888, **32**, 217.
22. Phot. Mitth. 1894, **30**, 16; 1910, **47**, 33.
23. Bull. Soc. Franc. Phot. 1896, (2), **12**, 371.

In the *finishing of collodio-chloride positives*,¹ a multitude of different processes have been advocated, depending upon the effects desired. Full description of these various processes are to be found in the recommendations of A. Bell,² Brandt,³ Burgess,⁴ W. Busing,⁵ M. Bussi,⁶ Durand,⁷ J. Truchehut,⁸ H. Fowler,⁹ A. Freund,¹⁰ O. Fulton and W. Gillard,¹¹ Guilleminot,¹² K. Helfen,¹³ I. Hoffsummer,¹⁴ J. Hutinet,¹⁵ M. Jolles and L. Lalienfeld,¹⁶ Kraus,¹⁷ A. Lainer,¹⁸ E. Liesegang,¹⁹ Mentz,²⁰ P. Moss,²¹ R. Reiss,²² B.

24. Phot. Mitth. 1893, **29**, 5; 1894, **30**, 92, Jahr. Phot. 1893, **7**, 51, Brit. J. Phot. 1892, **39**, 247.

25. Phot. Mitth. 1909, **46**, 302

1. In this connection see P. Meissner, E. P. 12870, 1896; C. Cam, E. P. 13580, 1886; J. France, E. P. 20964, 1889; F. Blaisdell, E. P. 639, 1905; H. Merville and Co., E. P. 28793, 1902; A. Huck and L. Fischer, E. P. 17311, 1902; C. Archer, E. P. 21537, 1902; 7583, 1903; T. Able, E. P. 12629, 1909; B. Borzykowski, E. P. 5412, 1907; W. Brings, D. R. P. 94737, 1896; G. de Neuville, E. P. 21913, 1905; C. Pietzner, E. P. 3822, 1906; A. Beaumont, E. P. 5109, 1906; A. Cobenzl, D. R. P. 102540, 1898; Neue Photographische Ges., D. R. P. 154101; Farbwerke vorm. Meister, Lucius & Bruning, E. P. 6769, 1898; Y. Schwartz, D. R. P. 140908, 1902; J. Hoffsummer, E. P. 3855, 1904. See also Brit. J. Phot. 1868, **15**, 417, 1901, **48**, 403; Phot. News, 1896, **40**, 462; 1899, **43**, 253; Bull. Soc. Franc. Phot. 1867, **13**, 213; 1884, 130; Phot. Woch. 1907, **21**, 2; Phot. Mitth. 1870, **6**, 233, 234; 1888, **24**, 115; 1890, **27**, 94, 1893, **29**, 101, 263, 1894, **30**, 370, 380, 1895, **32**, 401; 1898, **35**, 222, 239, 1904, **41**, 204, 1913, **50**, 148; Phot. Annual, 1895, 182, 1897, 195, 1898, 211; Jahr. Phot. 1897, **11**, 431, 1901, **15**, 130, 600, 659, 661, 662, 730, 1902, **16**, 636; 1903, **17**, 506, 593, 611; 1906, **20**, 599, 600, 1908, **22**, 529, 530, 568; 1909, **23**, 476, 1910, **24**, 609, 613, 1912, **26**, 632; Amat. Phot. 1897, **25**, 358, 1903, **39**, 46; Photography, 1891, **3**, 764; 1898, **10**, 338; Anthony's Phot. Bull. 1893, **24**, 760.

2. Phot. Mitth. 1899, **36**, 231

3. Phot. Mitth. 1894, **30**, 275, 333

4. See Eder's Handb. Phot. 1896, **2**, 349.

5. Phot. Mitth. 1895, **32**, 125

6. Brit. J. Phot. 1866, **13**, 236

7. Chem. Tech. Rep. 1869, **8**, 11, 90

8. E. P. 2465, 1864

9. E. P. 14077, 1866.

10. Chem. Tech. Rep. 1868, **7**, 11, 97.

11. E. P. 11219, 1903; abst. J. S. C. I. 1904, **23**, 622.

12. Bull. Soc. Franc. Phot. 1889, (2), **5**, 121.

13. Phot. News, 1901, **45**, 147.

14. Belg. P. 173882, 1903; E. P. 25390, 1903; abst. J. S. C. I. 1904, **23**, 622.

15. D. R. P. 18794, 1881; abst. Wag. Jahr. 1882, **28**, 1014; J. Hutinet and P. Lamy, E. P. 1538, 1881.

16. U. S. P. 732189, 1903; E. P. 11053, 1897; abst. J. S. C. I. 1898, **27**, 794.

17. Phot. Mitth. 1891, **28**, 256

18. Phot. Corr. 1900, **37**, 353.

19. Phot. News, 1884, **28**, 395; Chem. Tech. Rep. 1887, **26**, 1, 199.

• Brit. J. Phot. 1884, **31**, 390

20. Phot. Ztg. 1892, **16**, 198.

21. E. P. 2274, 1910.

22. Brit. J. Phot. 1900, **47**, 440.

Risse,¹ C. Schlettwein,² O. Scholzig,³ Seyewetz and Chicandard,⁴ G. Sternitzki,⁵ T. Sutton,⁶ C. Thompson,⁷ Vanderweyde,⁸ Vogel,⁹ E. J. Wall,¹⁰ and W. Woodbury.¹¹

The various processes for *enameling positives* are to be found fully discussed, and detailed directions given¹² in the methods of J. Adams,¹³ J. Atkinson,¹⁴ A. Ayton,¹⁵ C. Cain,¹⁶ A. Beaumont,¹⁷ Blanchard,¹⁸ J. Bodtker,¹⁹ B. Borzykowski,²⁰ C. Brandt,²¹ D. Carvalho,²² Chamussy,²³ E. Chappuis,²⁴ Claziez,²⁵ F. Colburn and J. France,²⁶ F. Cooper,²⁷ L. Degorce,²⁸ Despaquis,²⁹ C. Dicker,³⁰ E. Dunshy,³¹ J. Truchelut,³² H. Fowler,³³ J. France,³⁴ A. Gerlich,³⁵

1. Phot. News, 1891, **35**, 767.
2. Phot. Mitth. 1897, **34**, 251.
3. Brit. J. Phot. 1898, **45**, 827.
4. Bull. Soc. Franc. Phot. 1895, 408.
5. D. R. P. 110716, 1898.
6. Wieck's Gewerbeztg. 1867, 47.
7. E. P. 23815, 1905.
8. Bull. Soc. Franc. Phot. 1873, **19**, 149.
9. Phot. News, 1873, **17**, 516. See also Atelier, **18**, 78.
10. Bull. Soc. Franc. Phot. 1896, 277.
11. Phot. News, 1887, **31**, 98.
12. For information on this subject consult also Jahr. Phot. 1900, **14**, 604; 1903, **17**, 542; 1906, **20**, 523. Wieck's Gewerbeztg. 1869, 280. Phot. Mitth. 1867, **3**, 293; 1877, **13**, 91. Mon. Phot. 1867, **7**, 31; 1903, **10**, 293. Phot. Times, 1893, **23**, 760. Amat. Phot. 1901, **34**, 259; 1902, **35**, 200, 484; 1903, **37**, 503; 1904, **40**, 399; 1905, **41**, 99; 1908, **47**, 143; 1910, **51**, 377; 1913, **58**, 398; 1914, **60**, 402. Phot. News, 1867, **11**, 563; 1872, **16**, 183; 1873, **18**, 117, 451, 454, 477, 574; 1875, **19**, 151; 1878, **20**, 427; 1881, **25**, 97; 1888, **32**, 623, 824; 1900, **44**, 349; 1901, **45**, 31, 94; 1904, **48**, 702; 1906, **50**, 137, 217, 721. Brit. J. Phot. 1864, **11**, 360; 1867, **14**, 552; 1871, **18**, 143, 222; 1874, **21**, 191; 1876, **23**, 63, 397; 1879, **26**, 26; 1883, **30**, 199; 1884, **31**, 31, 98; 1897, **44**, 499; 1907, **54**, 263, 420; 1908, **55**, 98, 731; 1911, **58**, 233.
13. Brit. J. Phot. 1884, **31**, 13.
14. Brit. J. Phot. 1871, **18**, 142.
15. Brit. J. Phot. 1882, **29**, 137.
16. E. P. 13580, 1886; abst. Phot. News, 1887, **31**, 69; 1888, **32**, 337.
17. E. P. 5100, 1906.
18. Bull. Soc. Franc. Phot. 1867, **13**, 186; Phot. News, 1867, **11**, 241, 256.
19. U. S. P. 38144, 1863.
20. E. P. 5413, 1907; abst. Brit. J. Phot. 1907, **54**, 663.
21. U. S. P. 444084, 1891.
22. U. S. P. 225458 and re-issue 9384 thereof.
23. Phot. News, 1883, **27**, 403.
24. E. P. 21543, 1897.
25. Bull. Soc. Franc. Phot. 1886, (2), **2**, 142.
26. U. S. P. 429843, 1890.
27. Phot. News, 1890, **43**, 135.
28. F. P. 377039, 1907; abst. J. S. C. I. 1907, **26**, 1026.
29. Bull. Soc. Franc. Phot. 1868, **14**, 99, 101.
30. E. P. 18167, 1898.
31. Phot. News, 1874, **18**, 398.
32. E. P. 2465, 1864.

- Grenier Art Co.,¹ V. Griswold,² J. Gurney,³ H. Harley,⁴ A. Harth,⁵ F. Haugk,⁶ G. Hay,⁷ U. Heger,⁸ A. Henocque,⁹ Jarman,¹⁰ J. Johnson,¹¹ G. Langdell and M. Root,¹² C. Langlois,¹³ A. Lombardi,¹⁴ A. Matthys,¹⁵ P. Meissner,¹⁶ H. Merfille et Cie,¹⁷ Neue Photographische Ges.,¹⁸ F. O'Connor,¹⁹ F. Pereira,²⁰ J. Phelps,²¹ W. Picken,²² J. Pier,²³ Quesnay,²⁴ G. Richards,²⁵ G. Robey,²⁶ A. Rollason,²⁷ C. Rosier,²⁸ A. Schrabner,²⁹ E. Silsby,³⁰ W. Spicler,³¹ T. Sutton,³² F. Tarniquet,³³ J. Terreforte,³⁴ J. Towler,³⁵ W. Trenemen,³⁶ I. Webster,³⁷ F. Wenderoth,³⁸ L. Williams,³⁹ W. Williams,⁴⁰ and J.
33. E. P. 14077, 1896.
 34. E. P. 20964, 1889.
 35. D. R. P. 218346, 1908; *abst. Chem. Ztg. Rep.* 1910, **34**, 163.
 1. E. P. 13317, 1900.
 2. E. P. 3190, 1865.
 3. E. P. 2473, 1878.
 4. *Phot. News*, 1891, **35**, 263.
 5. E. P. 5055, 1888.
 6. *Phot. News*, 1872, **16**, 454; 1878, **22**, 302.
 7. E. P. 2808, 1855.
 8. *Brit. J. Phot.* 1897, **44**, 265.
 9. *La Nature*, 1884, **11**, 43.
 10. *Wilson's Mag.* 1907, **44**, 338.
 11. *Phot. News*, 1872, **16**, 100, 101. *Brit. J. Phot.* 1872, **19**, 104.
 12. U. S. P. 15341, 1856.
 13. E. P. 2254, 1856.
 14. E. P. 3196, 1878; *abst. Brit. J. Phot.* 1879, **26**, 150.
 15. *Brit. J. Phot.* 1864, **11**, 169. *Bull. Soc. Franc. Phot.* 1864, **10**, 188.
 - Mon. Phot.* 1864, **4**, 36.
 16. E. P. 12870, 1896.
 17. E. P. 28793, 1902.
 18. *Aust. P.* 3207, 1898.
 19. *Brit. J. Phot.* 1911, **58**, 673.
 20. E. P. 3358, 1903.
 21. *Phot. News*, 1887, **31**, 281.
 22. E. P. 21698, 1906.
 23. *Chem. Tech. Rep.* 1877, **16**, I, 443.
 24. *Phot. News*, 1875, **19**, 505.
 25. *Brit. J. Phot.* 1885, **12**, 55.
 26. E. P. 1960, 1883.
 27. E. P. 2143, 1864; *abst. Brit. J. Phot.* 1865, **12**, 430. See also *Poly. Centr.* 1859, **25**, 140.
 28. E. P. 16560, 1910; *abst. Brit. J. Phot.* 1911, **58**, 124.
 29. *Phot. News*, 1871, **15**, 476.
 30. U. S. P. 657749, 1900.
 31. U. S. P. 38847, 1863.
 32. *Wieck's Gewerbeztg.* 1887, 47.
 33. *Phot. News*, 1890, **34**, 618.
 34. U. S. P. 295688, 1884.
 35. *Phot. News*, 1889, **13**, 343.
 36. E. P. 4915, 1887.
 37. *Phot. News*, 1874, **18**, 553, 593.
 38. *Brit. J. Phot.* 1865, **12**, 449.
 39. E. P. 6906, 1893.
 40. U. S. P. 167485, 1875.

Schumacher and G. Stade,¹ to which the reader is referred.

Unless carefully prepared and strict attention to detail rigidly adhered to, it is often desirable to submit the collodion-chloride or similar photograph to a separate treatment to enhance its permanency.² Methods of so doing have been detailed by H. Baker,³ G. Hammer,⁴ W. Brigham,⁵ K. Buisson,⁶ H. Busbridge,⁷ D. Carnegie,⁸ B. Haldy,⁹ P. Hanneke,¹⁰ A. and L. Lumiere and A. Seyewetz,¹¹ C. Piper,¹² H. Robinson,¹³ W. Shenton,¹⁴ and W. Davenport.¹⁵

There has been considerable employment of *celluloid substratum for paper*. In the metalotype of C. Archer,¹⁶ map molding, sensitized films and cards, collodion has and is extensively employed, especially the thermoplastic nitrocelluloses such as celluloid. The various methods for the employment of this material are discussed in the communications of C. Archer, A. Beaumont,¹⁷ W. Brings,¹⁸ A. Cobenzl,¹⁹ Farbwerke vorm. Meister, Lucius & Brüning,²⁰ H. Fowler,²¹ O. Fulton and W. Gillard,²² J. and B.

1. E. P. 748, 1879

2. See Brit. J. Phot. 1899, **16**, 534, 608; 1884, **31**, 769; 1894, **41**, 580; 1895, **42**, 462, 559; 1898, **45**, 536, 707; 1902, **49**, 764, 799, 902; 1903, **50**, 283, 800, 1905, **52**, 183, 903, 918; 1908, **55**, 155; 1912, **59**, 235. Phot. News, 1858, **1**, 35. Meyer Jahr. Chem. 1893, **3**, 544. Amat Phot. 1891, **13**, 425. Phot. Annual, 1892, 97. Phot. Mitth. 1895, **31**, 92; 1896, **33**, 167, 181; 1897, **34**, 215; 1898, **35**, 21, 99; 1899, **36**, 41, 217; 1900, **37**, 18; 1906, **43**, 428; 1907, **44**, 553; 1910, **47**, 90.

3. Brit. J. Phot. 1905, **52**, 897

4. Brit. J. Phot. 1897, **44**, 278.

5. Brit. J. Phot. 1904, **57**, 872.

6. Brit. J. Phot. 1906, **53**, 122.

7. Brit. J. Phot. 1905, **52**, 858.

8. Brit. J. Phot. 1905, **52**, 878.

9. Phot. Mitth. 1909, **46**, 75.

10. Phot. Mitth. 1898, **35**, 214.

11. Bull. Soc. Franc. Phot. 1908, **24**, 461; abst. J. S. C. I. 1909, **28**, 109.

12. Brit. J. Phot. 1902, **49**, 798.

13. Phot. News, 1895, **9**, 147.

14. Brit. J. Phot. 1905, **52**, 939.

15. Brit. J. Phot. 1905, **52**, 957.

16. E. P. 21537, 1902; 7853, 1903.

17. E. P. 5109, 1906.

18. D. R. P. 94737, 1896.

19. D. R. P. 102540, 1898.

20. Aust. P. 1713, 1900. E. P. 6769, 1897; abst. Brit. J. Phot. 1898, **45**, 218.

21. E. P. 14077, 1896.

22. E. P. 23059, 1899; 11219, 1903; 6018, 1904; abst. J. S. C. I. 1905, **24**, 290.

Galay,¹ I. Hoffsummer,² A. Huck, and S. Fischer,³ J. Hutinet and P. Lamy,⁴ H. Kuhn,⁵ Koppmann,⁶ H. Kuhlert,⁷ C. Mackenzie and Inst. Phys. and Pol. Geography,⁸ Neue Photographische Ges.,⁹ F. de Neuville,¹⁰ C. Nienstadt,¹¹ Photochemische Fabrik R. Risse Ges.,¹² C. Pietzner,¹³ Y. Schwartz,¹⁴ and Union Photographique Industrielle (Établissements Lumière & Jougla Reims)¹⁵

*Collodion Carbon Prints.*¹⁶ In carbon printing, translucent paper effects, photo-ornamentation, photo mechanical printing, photographic pigment processes and chromotype printing, collodion has had many and varied uses. The details of these processes with their modifications, are contained in the writings and processes as disclosed by A. O. f. Anilinfabrikation,¹⁷ T. de Beauregard,¹⁸ W. Blair,¹⁹ R. Boerner,²⁰ T. Bolas,²¹ L. Borlinetto,²² E. Buhler,²³ J. Burgess,²⁴ J. Clark,²⁵ H. Cooper,²⁶ R. Krayn,²⁷ J.

1. E. P. 19772, 1909; U. S. P. 1011181, 1911, abst. J. S. C. I. 1910, **29**, 483; 1912, **31**, 24.
2. E. P. 25390, 1903, 3855, 1904, abst. J. S. C. I. 1904, **23**, 337.
3. D. R. P. 127899, 1901, 145282, 1902. E. P. 17311, 1902.
4. E. P. 1538, 1881; abst. Brit. J. Phot. 1881, **28**, 615.
5. E. P. 6921, 1891; abst. Brit. J. Phot. 1907, **54**, 7. U. S. P. 150963, 1891; 640137, 1899.
6. D. R. P. 81381, 1894.
7. D. R. P. 146276, 146034, 148664, 149799, 151973, abst. Wag. Jah. 1904, **50**, II, 478; Mon. Sci. 1906, **65**, 27, 28.
8. E. P. 3457, 1904.
9. D. R. P. 154101, 1903; abst. Chem. Ztg. 1904, **28**, 934.
10. E. P. 21913, 1905.
11. D. R. P. 29425, 1884.
12. F. P. 363086, 1906.
13. E. P. 3822, 1906.
14. E. P. 9992, 1902. E. P. 993, 1907, abst. Brit. J. Phot. 1907, **54**, 964.
15. D. R. P. 140908, 1902. F. P. 320452, 1902, abst. J. S. C. I. 1903, **22**, 14.
16. F. P. 448624, 1911.
17. Brit. J. Alm. 1899, 773, 1907, 629, 657, 1908, 698. Jah. Phot. 1900, **14**, 630, 1903, **17**, 550; 1904, **18**, 527, 1905, **19**, 9, 346, 454, 1909, **23**, 46, 48. Phot. Mitth. 1878, **14**, 18, 38, 1905, **42**, 332, 1907, **44**, 366. Phot. Ann. 1894, 70. Photography, 1903, **16**, 358. Mon. Phot. 1867, 1868, **7**, 172. Amat. Phot. 1903, **38**, 146. Phot. News, 1861, **5**, 19, 1881, **25**, 577, 1884, **28**, 329; 1887, **31**, 159; 1904, **48**, 15, 1906, **50**, 192. Brit. J. Phot. 1864, **11**, 138; 404, 1871, **18**, 408; 1876, **23**, 241; 1877, **24**, 82, 1878, **25**, 296, 1880, **27**, 62; 1881, **28**, 355, 589; 1892, **39**, 52, 1899, **46**, 189; 1906, **53**, 263, 520, 1039. See E. Farmer, Brit. J. Phot. 1883, **30**, 266.
18. D. R. P. 154539, 160665, 1903. F. P. 339654, 1904, abst. J. S. C. I. 1904, **23**, 727. E. P. 925, 1904.
19. E. P. 3066, 1857.
20. Brit. J. Phot. 1864, **11**, 318, 1866, **13**, 320.
21. E. P. 19889, 1907.
22. Brit. J. Phot. 1878, **25**, 410.
23. Phot. News, 1873, **18**, 149.
24. E. P. 12867, 1904; abst. J. S. C. I. 1906, **25**, 284.
25. Phot. News, 1865, **9**, 210.

Davenport,¹ G. Dawson,² Despaquis,³ E. Edwards,⁴ A. Fargier and N. Charavet,⁵ I. Favre,⁶ E. Foxlee,⁷ Friedlein,⁸ O. Fulton and M. Gillard,⁹ C. Gravier,¹⁰ A. Hans,¹¹ J. Harmer,¹² P. Jastrzembski,¹³ J. Johnson,¹⁴ G. Kemp,¹⁵ H. Lambert,¹⁶ R. Laurent,¹⁷ M. Lea,¹⁸ A. Marion,¹⁹ C. Meinerth,²⁰ Metalline Platten Ges.,²¹ A. Montagna,²² R. Namias,²³ Neue Photographische Ges.,²⁴ J. Nicol,²⁵ A. Ott,²⁶ T. Parkyns,²⁷ Passavant,²⁸ M. Poitevin,²⁹ Pouncy,³⁰ D. Power,³¹ M. Raphael,³² F. Rowell,³³ O. Sarony and R. Johnson,³⁴ H. Schmidt,³⁵ G. Sershall,³⁶ J. Smith,³⁷ J. Spencer,³⁸ T. Sutton,³⁹ J. Swan,⁴⁰ P. and

25. E. P. 11254, 1892.
26. Brit. J. Phot. 1864, **11**, 221, 232.
27. Brit. J. Phot. 1907, **54**, 80. E. P. 13093, 1902.
1. Brit. J. Phot. 1869, **16**, 334.
2. Brit. J. Phot. 1864, **11**, 164, 182.
3. Bull. Soc. Franc. Phot. 1868, **14**, 9, 144.
4. E. P. 2201, 1868.
5. E. P. 955, 1861.
6. E. P. 1569, 1880; 18016, 1880.
7. Brit. J. Phot. 1873, **20**, 80; 1894, **38**, 101.
8. Brit. J. Phot. 1877, **24**, 127. Phot. Korr. 1893, No. 391.
9. E. P. 23059, 1899.
10. Bull. Soc. Franc. Phot. 1911, (3), **2**, 242; abst. C. A. 1911, **5**, 3660.
11. Swiss P. 46851, 1909.
12. Brit. J. Phot. 1883, **30**, 130.
13. Chem. Tech. Rep. 1877, **16**, I, 425.
14. E. P. 336, 1869; Brit. J. Phot. 1869, **16**, 241, 398; 1871, **18**, 9, 20, 33; 1877, **24**, 532; 1878, **25**, 11. Phot. News, 1876, **20**, 10.
15. Brit. J. Phot. 1864, **11**, 128.
16. E. P. 142, 1877. Brit. J. Phot. 1875, **22**, 409; 1877, **24**, 494. Phot. News, 1875, **19**, 345.
17. Phot. Times, 1878, **8**, 54.
18. Brit. J. Phot. 1869, **16**, 224.
19. E. P. 1206, 1868; abst. Brit. J. Phot. 1868, **15**, 567.
20. Phot. News, 1878, **22**, 17.
21. D. R. P. 137267.
22. Brit. J. Phot. 1868, **15**, 20, 194.
23. E. P. 4361, 1907.
24. D. R. P. 152797, 1901.
25. Brit. J. Phot. 1878, **25**, 363.
26. Chem. Tech. Rep. 1879, **18**, I, 239.
27. E. P. 3222, 1877; abst. Phot. News, 1878, **22**, 159; Brit. J. Phot. 1878, **25**, 157.
28. Brit. J. Phot. 1885, **32**, 456.
29. Brit. J. Phot. 1861, **8**, 249.
30. Brit. J. Phot. 1864, **11**, 313.
31. Brit. J. Phot. 1900, **47**, 662. Phot. News, 1906, **50**, 961.
32. D. R. P. 66730, 1891.
33. Phot. News, 1878, **22**, 592.
34. Chem. Tech. Rep. 1879, **18**, I, 242.
35. E. P. 17610, 1904; abst. J. S. C. I. 1904, **23**, 998.
36. E. P. 3121, 1897.
37. Brit. J. Phot. 1877, **24**, 256.
38. Brit. J. Phot. 1877, **24**, 403.

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*Collodion Transparencies. Lantern Slides.*⁹ The employment of the cellulose nitrates in diagrammatic lantern slide, window transparencies (cellulograph), negative reproduction, composite photographs, diapositives, hyalotypes and stereoscopic transparency printing, dates back to the earlier days of photographic collodion technology. Those interested in the details of these processes and their manifold ramifications, will find abundant information in the communications of W. Abney,¹⁰ T. Armstrong,¹¹ W. Adams,¹² Audra,¹³ S. Bamforth,¹⁴ W. Bashford,¹⁵ F. Beach,¹⁶

39. Brit. J. Phot. 1871, **18**, 32.
40. E. P. 503, 1864; 1791, 1865, abstr. Brit. J. Phot. 1864, **11**, 331, 412.
1. F. P. 434791, 1910; abstr. J. S. C. I. 1912, **31**, 303.
2. E. P. 4915, 1887.
3. Brit. J. Phot. 1876, **23**, 115.
4. Brit. J. Phot. 1877, **24**, 69.
5. Phot. News, 1906, **50**, 490.
6. E. P. 376, 1891.
7. Atelier Phot. **19**, 87; abstr. C. A. 1912, **6**, 2582.
8. Brit. J. Phot. 1881, **28**, 318.
9. In this connection see Phot. Times, 1880, **19**, 24, 1890, **20**, 173, 326, 575. Anthony's Phot. Annual, 1891, **4**, 221. Poly. Centr. 1864, **30**, 1267. Amat. Phot. 1887, **6**, 190, 1888, **8**, 207; 1892, **15**, 329, 1895, **21**, 31, 1896, **23**, 551; 1898, **27**, 296; 1900, **31**, 61; 1905, **41**, 321. Phot. Annual, 1892, 85; 1893, 66, 67, 264; 1896, 160, 167, 198; 1898, 89. Amer. J. Phot. 1891, **12**, 79. Camera, 1894, **7**, 14. Jahr. Phot. 1891, **5**, 503; 1892, **6**, 425; 1898, **12**, 428; 1901, **15**, 659; 1906, **20**, 511; 1911, **25**, 338; 1913, **27**, 273, 430. Phot. Mitth. 1880, **16**, 29, 1881, **17**, 163; 1896, 1897, **33**, 13, 15, 1897, 1898, **34**, 114; 1905, **42**, 308. Brit. J. Alm. 1888, 327; 1891, 489; 1892, 579. Photography, 1890, **2**, 46, 760; 1891, **3**, 28, 514, 549, 1892, **4**, 218, 1899, **11**, 479, 584. Chem. Tech. Rep. 1891, **30**, 11, 220. Bull. Soc. Franc. Phot. 1892, (2), **8**, 500. Brit. J. Phot. 1861, **8**, 94; 1864, **11**, 19, 379, 1865, **12**, 13; 1869, **16**, 364, 1872, **19**, 33; 1874, **21**, 527, 539; 1875, **22**, 482, 1879, **26**, 252; 1881, **28**, 214, 1882, **29**, 161, 177, 221; 1883, **30**, 769; 1884, **31**, 5, 673, 737, 769, 801, 1885, **32**, 7, 17, 35, 65, 81, 97, 113, 129, 145, 161, 803; 1888, **35**, 249, 489, 518; 1890, **37**, 577, 594, 609, 771, 785; 1891, **38**, 721, 738, 754, 787; 1892, **39**, 63; 1893, **40**, 153, 1895, **42**, 24, 673; 1897, **44**, 690; 1898, **45**, 803; 1902, **49**, 344; 1907, **54**, 955, 976; 1908, **55**, 767. Phot. News, 1858, **1**, 24, 35; 1859, **3**, 98, 405, 1861, **5**, 531; 1862, **6**, 41; 1867, **11**, 284; 1868, **12**, 217; 1875, **19**, 603; 1876, **20**, 271; 1883, **27**, 482, 818; 1884, **28**, 401; 1885, **29**, 190; 1886, **30**, 684, 693; 1891, **35**, 218; 1892, **36**, 570; 1897, **41**, 628; 1899, **43**, 630; 1901, **45**, 46; 1902, **46**, 169; 1903, **47**, 631, 667; 1906, **49**, 430.
10. Phot. News, 1881, **25**, 499.
11. Brit. J. Phot. 1886, **32**, 120, 404, 791, 821; 1888, **35**, 437, 472, 505, 534, 550, 566, 581, 596, 613. Phot. News, 1881, **25**, 499.
12. E. P. 16785, 1888.
13. Bull. Soc. Franc. Phot. 1873, **19**, 209.
14. Brit. J. Phot. 1886, **33**, 721.
15. Brit. J. Phot. 1878, **25**, 125.
16. Jahr. Phot. 1894, **4**, 331.

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1. Phot. News, 1899, **43**, 631.
 2. Poly. Centr. 1886, **22**, 874.
 3. Brit. J. Phot. 1887, **34**, 804; 1891, **38**, 196; 1897, **44**, 245, 629. Brit.
 J. Phot. Suppl. 1892, **39**, 18; 1893, **40**, 20, 43, 114; 1895, **42**, 9
 4. E. P. 3080, 1861.
 5. Phot. News, 1886, **30**, 165.
 6. Phot. News, 1877, **21**, 61. Brit. J. Phot. 1884, **31**, 789; 1888, **35**,
 - 575 Bull. Soc. Franc. Phot. 1880, **26**, 15.
 7. Phot. News, 1896, **40**, 644.
 8. Bull. Soc. Franc. Phot. 1868, **14**, 267.
 9. Phot. News, 1888, **32**, 340.
 10. Phot. News, 1879, **23**, 376.
 11. E. P. 2139, 1855.
 12. Phot. News, 1891, **35**, 253.
 13. E. P. 1638, 1854; J. Frankl. Inst. 1855, Amer. J. Pharm. 1855, **27**,
 - 551.
 14. Bull. Soc. Franc. Phot. 1859, **5**, 114.
 15. Phot. News, 1896, **40**, 635, Suppl. 8
 16. Phot. News, 1893, **37**, 5.
 17. Brit. J. Phot. 1888, **35**, 538
 18. Brit. J. Phot. 1861, **8**, 182.
 19. E. P. 20660, 1898; abst. Brit. J. Phot. 1899, **46**, Suppl. 72
 20. E. P. 2315, 1857. See also Phot. News, 1861, **5**, 265 Chem
 Tech. Rep. 1867, **6**, II, 69. Mon. Phot. 1878, **17**, 185.
 21. Phot. Mitth. 1896-1897, **33**, 162.
 22. Phot. News, 1860, **4**, 220, 257.
 23. Phot. News, 1858, **1**, 111.
 24. Phot. News, 1878, **22**, 196.
 25. Brit. J. Phot. 1886, **33**, 748
 26. Phot. Mitth. 1867, **4**, 52, Chem. Tech. Rep. 1867, **6**, I, 75
 27. Phot. News, 1891, **35**, 796.
 28. Phot. News, 1878, **22**, 140.
 29. Photography, 1904, 117; Jahr. Phot. 1904, **18**, 480.
 30. Brit. J. Phot. 1869, **16**, 568. See also W. J. Harrison, Brit. J.
 Phot. 1889, **36**, 813.
 31. Phot. Times, 1895, **28**, 510.
 32. Phot. News, 1898, **42**, 647.
 33. Phot. News, 1880, **33**, 614
 34. Phot. Corr. 1885, **32**, 556.
 35. Hunt's Manual of Phot. 1857, 84.
 36. E. P. 4193, 1873.
 37. Brit. J. Phot. 1875, **22**, 8
 38. Poly. Centr. 1856, **22**, 1148.
 39. E. P. 693, 1852.
 40. Phot. News, 1896, **40**, 633. Brit. J. Phot. 1897, **44**, 381

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 Sans,¹⁶ E. Schering,¹⁷ J. Schnauss,¹⁸ G. Schmitzler,¹⁹ H. Schwarz,²⁰
 H. Smith,²¹ J. Stevens,²² J. Teape,²³ F. Tournachon,²⁴ J. Towler,²⁵
 J. Tulloch,²⁶ E. Wallace,²⁷ Wandolleck,²⁸ A. Watt,²⁹ Weiske,³⁰ J.
 Wellington,³¹ W. Wilkinson,³² J. Williams,³³ and C. Woods.³⁴

*Enlarging Positives on Paper and Glass.*³⁵ *The employment
 of collodion for transparent positives for enlargement, the

41. Brit. J. Phot. 1861, **8**, 270. Phot. News, 1861, **5**, 339
42. Poly. Centr. 1854, **20**, 124
1. Phot. News, 1899, **43**, 630.
2. Mon. Phot. 1866-1867, **6**, 190.
3. Phot. News, 1885, **29**, 811
4. Phot. Mitth. 1896-1897, **33**, 357.
5. Inst. 1856, 93; abst. Jahr. Chem. 1856, **9**, 192
6. Phot. News, 1874, **18**, 344. Amat. Phot. 1893, **18**, 183
7. E. P. 3358, 1903.
8. Phot. News, 1884, **28**, 679
9. Phot. Mitth. 1896-1897, **33**, 149. Phot. Corr. 1896, **33**, 329
10. E. P. 14171, 1888.
11. Phot. Rundschau, 1899, **13**, 7.
12. Phot. Mitth. 1896-1897, **33**, 179
13. Jahr. Phot. 1887, **1**, 215
14. Brit. J. Phot. 1883, **30**, 8.
15. Phot. J. (Horn's), **18**, 20, 50. Phot. News, 1860, **4**, 278, 1862, **6**, 367, 378, 389.
16. Bull. Soc. Franc. Phot. 1873, **19**, 41
17. Brit. J. Phot. 1864, **11**, 256
18. Phot. News, 1876, **20**, 176
19. E. P. 7867, 1897
20. Phot. Archiv.; Humphrey's J.; abst. Brit. J. Phot. 1866, **13**, 585
21. U. S. P. 14300, 1856.
22. Brit. J. Phot. Suppl. 1893, **40**, 29.
23. Phot. News, 1895, **39**, 26, 1902, **46**, 607, 1903, **47**, 446, 1905, **49**, 366.
24. Bull. Soc. Franc. Phot. 1895, (2), **11**, 276. Phot. Times, 1895, **26**, 152
25. Brit. J. Phot. 1895, **42**, 24. Phot. Annual, 1896, 167. Brit. J. Alm. 1896, 813. Jahr. Phot. 1896, **20**, 497.
26. E. P. 508, 1861.
27. Brit. J. Phot. 1869, **16**, 387.
28. Phot. News, 1893, **37**, 182.
29. Brit. J. Phot. 1888, **35**, 824.
30. Bull. Soc. Franc. Phot. 1901, (2), **17**, 119. Mon. Sci. 1902, **16**, 401.
31. abst. J. S. C. I. 1902, **21**, 989.
32. Phot. News, 1859, **3**, 113.
33. Wieck's Gewerbeztg. 1864, 302
34. Phot. News, 1886, **30**, 684. Brit. J. Phot. 1886, **33**, 683. Phot. Centr. 1895, **1**, 41.
35. Brit. J. Phot. 1882, **29**, 125
36. Brit. J. Phot. 1898, **45**, Suppl. 2
37. Phot. News, 1882, **26**, 261.
38. See Brit. J. Phot. 1864, **11**, 318, 434, 1873, **20**, 14; 1884, **31**, 674; 1885, **32**, 640. Phot. News, 1865, **9**, 365; 1872, **16**, 469, 1876, **20**, 234; 1877, **21**, 261; 1884, **28**, 721. Yearbook Phot. 1893, 333.

so-called collodion transfers and in general for copying and enlarging, has been an important branch of cellulose ester photographic application. The advances and intricacies of this field of the art is reflected in the methods and devices of W. Brooks,¹ F. Dore,² W. Harrison,³ A. Jarman,⁴ von Kolkow,⁵ Kyrkow,⁶ Liesegang,⁷ D. v. Monckhoven,⁸ W. Morgan,⁹ Solomon,¹⁰ J. Towler,¹¹ Villette,¹² W. Wheeler,¹³ and W. Wilkinson.¹⁴

Collodion Positives and Transfers,¹⁵ or the transfer of negative images to paper and including the production of pellicle, clichés, constitute an interesting portion of pyroxylin development as applied to photography. The development of this subject primarily rests upon the work of Arentz,¹⁶ J. Atkinson,¹⁷ W. Bolton,¹⁸ G. Bradforde,¹⁹ G. Croughton,²⁰ R. Fowler,²¹ G. Dawson,²² C. Durand,²³ T. Farmer and F. Lewis,²⁴ C. Fleck,²⁵ C. Fontayne,²⁶ M. Geymet,²⁷ F. Haugk,²⁸ H. Jennings,²⁹ A. Londe,³⁰ A. Marion,³¹

1. Phot. Mitth. 1878, **15**, 38; 1884, **21**, 74. Phot. News, 1878, **22**, 219. Bull. Soc. Franc. Phot. 1877, **23**, 267.
2. Brit. J. Phot. 1876, **23**, 250.
3. Brit. J. Phot. 1879, **26**, 8.
4. Phot. News, 1904, **48**, 134.
5. Phot. News, 1877, **21**, 209.
6. Phot. Korr 1885, **32**, 556.
7. Phot. News, 1876, **20**, 459.
8. Phot. Mitth. 1889, 201, 212, 286.
9. Brit. J. Phot. 1873, **20**, 134.
10. Phot. News, 1874, **18**, 75.
11. Phot. News, 1870, **14**, 474, 484. Brit. J. Phot. 1870, **17**, 499.
12. Wieck's Gewerbeztg. 1866, 47; Chem. Tech. Rep. 1865, **4**, I, 87.
13. Phot. News, 1875, **19**, 578.
14. Phot. News, 1876, **20**, 232.
15. In this connection see also Brit. J. Phot. 1866, **13**, 341; 1869, **16**, 141, 331; 1877, **24**, 349, 362; 1879, **26**, 80, 120, 132; 1880, **27**, 1, 367; 1881, **28**, 178, 231; 1889, **36**, 693; 1894, **41**, 82. Phot. News, 1861, **5**, 239; 1870, **14**, 495; 1872, **16**, 373; 1879, **23**, 258; 1880, **24**, 228. Sci. Amer. Suppl. 1880, 3439. Amat. Phot. 1903, **37**, 179. Phot. Bull. 1880, **11**, 10, 85.
16. Phot. News, 1880, **24**, 297.
17. Brit. J. Phot. 1869, **16**, 152.
18. Brit. J. Phot. Suppl. 1893, **40**, 100.
19. Phot. News, 1880, **24**, 344.
20. Phot. News, 1881, **25**, 54.
21. Brit. J. Phot. 1866, **13**, 624.
22. Brit. J. Phot. 1869, **16**, 528; 1880, **27**, 341, 391.
23. Phot. News, 1869, **13**, 330.
24. E. P. 831, 1865; abst. Brit. J. Phot. 1866, **13**, 116.
25. Brit. J. Phot. 1898, **45**, 584.
26. U. S. P. 208584, 1878.
27. Brit. J. Phot. 1867, **14**, 461; 1873, **20**, 307.
28. Phot. News, 1878, **22**, 111.
29. Phot. Times, 1875, **5**, 214.
30. Bull. Soc. Franc. Phot. 1896, **12**, 209.
31. E. P. 1206, 1868.

W. Morgan,¹ C. Quesnay,² D. Robertson,³ O. Sarony,⁴ J. Schnauss,⁵
J. Schumacher⁶ and W. Wilkinson.⁷

Orthochromatic Emulsion.⁸ The preparation of the ordinary

1. Phot. News, 1873, **17**, 136; 1879, **23**, 250; Wilson's Phot. Mosaics, 1874, **27**; Bull. Soc. Franc. Phot. 1873, **19**, 109. See also Brit. J. Phot. 1879, **26**, 349.
2. Phot. News, 1876, **20**, 113.
3. Brit. J. Phot. 1881, **28**, 169.
4. E. P. 725, 1858. See also Brit. J. Phot. 1869, **16**, 120.
5. Dingl. Poly. 1860, **156**, 431. Chem. Centr. 1860, **31**, 1023.
6. U. S. P. 220435, 1879.
7. Brit. J. Phot. 1880, **27**, 358.
8. Aarland, Phot. Rund., 1894, **8**, 103. A.-G. f. Anilinfabrikation, D. R. P. 127771, 1901; abst. Archiv. wiss. Phot. 1901, 275; Eder's Jahr. Phot. 1895, **72**, 97, 250. W. Abney, Brit. J. Phot. 1880, **27**, 582, 1882, **29**, 320; Phot. News, 1878, **22**, 256, 482; 1888, **32**, 642, 707. T. Baker, Phot. J. 1907, **47**, 207; abst. J. S. C. I. 1907, **26**, 715. E. Becquerel, Bull. Soc. Franc. Phot. 1874, **20**, 233. J. Clarke, Phot. News, 1861, **5**, 490. J. Eder, Phot. News, 1886, **30**, 474; 1888, **32**, 388; Chem. Tech. Rep. 1888, **27**, 11, 186. The Franklin Tarsulat, E. P. 14073, 1903, abst. Brit. J. Phot. 1903, **50**, 507. Florence, Phot. Centr. 1895, **1**, 138. J. Gatehouse, Phot. Times, 1875, **5**, 269. G. Garjeanne, Brit. J. Phot. 1884, **31**, 592. W. Goodwin, Phot. News, 1884, **28**, 759. A. v. Hübl, Phot. Rundschau, 1893, **7**, 3; Brit. J. Phot. 1897, **44**, 344; Zts. Reprod. 1902, **4**, 13. H. Klein, Graphic Arts and Crafts Book, 1910. A. Korth, Zts. Reprod. **13**, 7, 26. C. Lea, Phot. News, 1867, **11**, 396; Bull. Soc. Franc. Phot. 1874, **20**, 187. Luppö-Cramer, Phot. Korr. 1902, **39**, 699; abst. Chem. Ztg. Rep. 1903, **27**, 16; J. S. C. I. 1903, **22**, 164. F. Mallmann, Phot. News, 1886, **30**, 314. C. Stuerenburg, Phot. News, 1887, **31**, 93. W. Stillman, Brit. J. Phot. 1875, **22**, 316. F. Schanz, Zts. wiss. Phot. 1918, **17**, 261; abst. J. S. C. I. 1918, **37**, 637-A. Schultz-Sellack, Brit. J. Phot. 1871, **18**, 233, 264. J. Plener, E. P. 48906, 1881. Van Beck, Zts. Reprod. 1902, **4**, 59. H. Vogel, U. S. P. 235831, 1880; E. P. 2162, 1880; Phot. News, 1876, **20**, 265; 1884, **28**, 274; 1886, **30**, 130, 541, 1888, **32**, 693; 1890, **34**, 239; Brit. J. Phot. 1874, **21**, 29; 1876, **23**, 233; 1880, **27**, 403, 571; 1882, **29**, 632; 1884, **31**, 344; Arch. Pharm. 1875, **180**; abst. Amer. J. Pharm. 1875, **47**, 326; Chem. Tech. Rep. 1888, **27**, 11, 185; Phot. Mitth. 1882, **21**, 33, 44, 78. W. Wilkinson, Brit. J. Phot. 1913, **60**, 424; Le Procède, 1913, 131. J. Waterhouse, Phot. News, 1889, **33**, 71; 1892, **36**, 151, 163, 179. G. White and C. Alden, E. P. 446, 1864. J. Wolfram, D. R. P. 12266; abst. Wag. Jahr. 1881, **27**, 904; E. P. 847, 1880. J. Wellington, Phot. News, 1888, **32**, 415; Chem. Tech. Rep. 1887, **26**, 1, 195. Anon., Phot. News, 1866, **10**, 498; 1873, **17**, 589; 1875, **19**, 85; 1878, **22**, 263, 479; 1883, **27**, 251, 466; 1885, **29**, 380; 1888, **32**, 657; 1890, **34**, 961; 1891, **35**, 381, 408. Brit. J. Phot. 1874, **21**, 121, 398, 617; 1875, **22**, 403, 450; 1879, **26**, 248; 1882, **29**, 388; 1884, **31**, 360; 1904, **51**, 66, 107; 1907, **54**, 386, 464, 842; 1916, **63**, 504. Phot. Rundschau, 1893, **7**, 3. Mon. Phot. 1904, **11**, 8. Amat. Phot. 1901, **33**, 146. Photography Annual, 1891, 91; 1892, 83, 109, 111; 1893, 115. Photography, 1901, **11**, 63; Amer. J. Phot. 1888, **9**, 21, 172. Chem. Tech. Rep. 1887, **26**, I, 193; 1888, **27**, II, 186; Eder's Jahr. Phot. 1888, **2**, 126; 1889, **3**, 120; 1891, **5**, 180, 189, 191, 455, 460; 1892, **6**, 35, 273, 386, 387, 425, 428; 1893, **7**, 403; 1895, **9**, 430; 1902, **16**, 518; 1904, **11**, 3, 4, 5, 390, 391, 490, 481; 1906, **21**, 308; 1907, **21**, 406, 510; 1908, **22**, 370. W. Newton, E. P. 1511, 1857, was for "an improved method of applying photography to the use of engravers."

For additional data on this subject refer to H. Vogel, Ber. 1873, **6**, 1306; Phot. Mitth. 1873, **9**, 236; Pogg. Ann. Phys. 1874, **153**, 218; Phot.

(i. e., non-color sensitive) emulsion has already been historically touched upon (p. 2800), and it may be generally assumed that any such emulsion can be rendered color sensitive, either by bathing the coated plates in solution of dyes, or adding the same to the emulsion before coating. It has been generally found, however, that emulsions produced in some particular manner will give better results than others, and these will be briefly dealt with in this section.

An orthochromatic collodion emulsion had been used by E. Albert¹ in 1882 for the reproduction of oil paintings, the emulsion—called by him "Eos"—being made isochromatic for three-color photography by dissolving the silver salt of eosin in ammonia, neutralizing the alkali with picric acid, this preparation containing silver eoside and ammonium picrate. By this treatment the tendency to fog is inhibited, while the ammonium picrate absorbs the ultraviolet rays.² A plain emulsion was sent out with two sensitizing solutions, "eosin silver P," and "eosin silver R," the former intended for portraits and landscapes (being only green and yellow sensitive), and these were added to the plain emulsion just before use.

J. Eder³ evolved an orthochromatic emulsion, which, however, on account of containing a trace of free silver nitrate, would not keep for any considerable length of time. F. Ives⁴ used chlorophyl as a sensitizer as first suggested by E. Becquerel,⁵ in conjunction

News, 1873, **17**, 580. Eder, Brit. J. Phot. 1874, **21**, 198, 617. M. Sanders, Kreutzer's Zts. 1861, **3**, 106. Aitken and Cooper, Phot. Mitth. 1875, **11**, 18. J. Waterhouse, Brit. J. Phot. 1875, **22**, 450. Scotellari, Phot. Mitth. 1878, **14**, 208. See H. Vogel, Pogg. Ann. 1874, **153**, 233, Ber. 1874, **7**, 276, Phot. Mitt. 1876, **12**, 286. L. du Hauron, "Traité pratique de Photographie des Couleurs, Paris, 1878," Phot. Archiv. 1878, 109; Eder's Handb. 1896, **2**, 449. C. Cros, Compt. rend. 1878, **88**, 119, 378; Phot. Korr. 1879, 107. J. Eder, Wien. Akad. Ber. 1913, 122; Jahr. Phot. 1913, **27**, 188. W. Wilkinson, Brit. J. Phot. 1913, **60**, 424, Le Procédé, 1913, 131; Jahr. Phot. 1914, **28**, 329. J. Calmels and P. Clerc, Brit. J. Phot. 1905, **52**, 34; Annual Phot. 1906, 779. A. Payne, Penrose's Annual, 1907-1908, 118.

1. Phot. Korr. 1888, 251; Jahr. Phot. 1889, **3**, 407. Chem. Tech. Rep. 1888, **27**, I, 153; Phot. Korr. 1897, **34**, 193. D. R. P. 160666, abst. Wag. Jahr. 1905, **51**, II, 514. D. R. P. 237877; abst. C. A. 1912, **6**, 1890; J. S. C. I. 1911, **30**, 1410; Zts. ang. Chem. 1911, **24**, 1880; Wag. Jahr. 1911, **57**, II, 507; Phot. Chron. 1912, 57; Jahr. Phot. 1912, **26**, 476. Cf. G. White and C. Alden, E. P. 446, 1884.

2. Phot. Korr. 1888, 251; Jahr. Phot. 1889, **3**, 407.

3. Phot. Korr. May 1888; Jahr. Phot. 1889, **3**, 121; Eder Handb. Phot. 1896, **2**, 444.

4. Brit. J. Phot. 1886, **31**, 651; Phot. Woch. 1887, 21.

5. Compt. rend. 1874, **79**, 185; Bull. Soc. Franc. Phot. 1874, **20**, 233.

with eosin. Zenger¹ and Guignet² also employed chlorophyl. H. Vogel³ employed alcoholic solutions of rosanilin, aldehyde green or naphthalin red. F. Mallmann and C. Seolik,⁴ and J. Eder⁵ used a silver eoside sensitizer, while A. v. Hubl⁶ used unwashed zinc bromide emulsion with eosin, neutralizing excess of acid by sodium salicylate. Jonas⁷ followed the ideas of the latter.

The most extended research on orthochromatic emulsion is probably that of A. v. Hubl,⁸ who used both a pure bromide and a bromochloride emulsion the latter being the better, and was sensitized with chlorophyl or cyanin, in conjunction with narcotine. He worked out the details of commercial silver eoside production, which were improved upon by J. Eder.⁹ E. Stenger and H. Heller¹⁰ carried out valuable researches on the relative sensitiveness of various compounds including tetrabrom fluorescein, diiodo-, dichlor-, tetraiododichlor-, tetrabromdichlor, fluorescein, and tetrabromfluorescein ethyl ester. Uranine A (tribrom mononitrofluorescein), and tetrabromdinitrofluorescein showed no sensitizing action. He also investigated and published the detailed action of cyanin, diethyleyanin, dimethylquinolin ethylate, pinaverdöl, ethyl red, pinachrom, isocol, pinacyanol of the cyanin and isocyanin group, as well as congo red,¹¹ glycine corinth,¹² glycine

Eder Handb. Phot. 1896, **2**, 443, **3**, 148; Ber. 1875, **8**, 1636. Cf. E. Wall, Phot. J. 1895, **19**, 170.

1. Zenger's "Meteorologie der Sonne," 1885, Phot. Woch. 1886, 340, Jahr. Phot. 1888, **2**, 467.

2. Compt. rend. 1885, **100**, 433, Phot. Woch. 1886, 355. Kayser's Handb. Spektroskopie, 1908, **4**, 30. Eder Handb. Phot. 1896, **2**, 481. Cf. Ives, Phot. News, 1884, **28**, 819, Phot. Woch. 1887, **21**; Brit. J. Phot. 1886, **31**, 651; Jahr. Phot. 1888, **2**, 467, Eder Handb. Phot. 1896, **2**, 482. See also Wien Akad. Ber. 1915, **124**, II-a, 16, Chem. Zentr. 1916, **87**, I, 888, C. A. 1917, **11**, 1796.

3. "Die Photographie farbiger Gegenstände," 1885, 44.

4. Jahr. Phot. 1889, **3**, 407, Chem. Tech. Rep. 1887, **26**, II, 210, Phot. Times, 1888, **18**, 20.

5. Jahr. Phot. 1889, **3**, 120.

6. Phot. Korr. 1889, **3**, 407.

7. Phot. Korr. 1891, 372, Amat. Phot. 1891, **14**, 46, Phot. J. 1891, **16**, 65, Phot. News, 1892, **36**, 151; Jahr. Phot. 1892, **6**, 35, Eder Handb. Phot. 1896, **2**, 418, 459, 476. Phot. Ann. 1893, 115.

8. "Die Colloidum Emulsion," 1894.

9. Phot. Korr. 1889, 108.

10. Brit. J. Phot. 1908, **55**, 418, Zts. Reprod. 1908, **9**, No. 7, 8. Compt. rend. 1908, **146**, 309; Zts. wiss. Phot. 1908, **5**, 372, Jahr. Phot. 1909, **23**, 370.

11. Benzidine-disazo-di-1-naphthylamine-4-sulfonic acid

12. α -Naphthylglycine-1-naphthylamine-4-sulfonic acid.

red,¹ thiazol yellow,² dimethylquinoline ethylate, and combinations of the above, in conjunction with silver salts.

A. Newton and A. Bull³ in a research on sensitizers and color-sensitive plates, have reported upon the manipulative details of the use of "Albert's emulsion A sensitizer," Brend'Amour emulsion A sensitizer, Klinisch emulsion A sensitizer, and Penrose's C sensitizer, giving valuable and workable formulae.

E. Albert⁴ has patented a special method of making color sensitive plates, and likewise has A. v. Hübl.⁵ About the time the Farbwerke vorm. Meister, Lucius u. Brünig introduced isocyanin,⁶ A. v. Hübl recommended a combination of pinaverdol, ethyl violet and collodion emulsion for panchromatizing emulsions, which has been extensively used. E. Albert⁷ introduced a new method of sensitizing two dye solutions—one for green sensitizing and the other for red, which was tested out and approved by E. Valenta.⁸ The latter also tested other isocyanine dye-stuffs, particularly pinacyanol.

J. Waterhouse,⁹ T. Baker,¹⁰ C. Bothamley,¹¹ F. Schanz,¹² H. Klein,¹³ L. Schörner,¹⁴ G. Minchin,¹⁵ L. du Haeron¹⁶ and others¹⁷ have contributed to this phase of the subject, including investigation of ethyl violet,¹⁸ diiodofluorescein,¹⁹ and the aurin-collodion

1. Benzidine-disazo- α -naphthylglycin-1-naphthylamine-4-sulfonic acid.
2. Thiazol yellow G (Bayer), a diazo-amido compound of dehydrothiotoluidine sulfonic acid.
3. Phot. J. 1903, **43**, 262; Jahr. Phot. 1903, **13**, 388.
4. D. R. P. 160606; abst. Jahr. Phot. 1906, **20**, 510.
5. Jahr. Phot. 1897, **11**, 168.
6. D. R. P. 154475, 1903; abst. Jahr. Phot. 1904, **14**, 3, 390.
7. Phot. Korr. 1904, 125; Jahr. Phot. 1904, **14**, 390.
8. Phot. Korr. 1904, 126; Jahr. Phot. 1904, **14**, 391. In this connection consult also Atel. d. Phot. 1906, 14; abst. Jahr. Phot. 1906, **20**, 413.
9. Brit. J. Phot. 1875, **22**, 594.
10. Phot. J. 1907, **47**, 207.
11. Phot. News, 1887, **31**, 805.
12. Zts. wiss. Phot. 1918, **17**, 261; abst. C. A. 1919, **13**, 1679. Cf. C. A. 1918, **12**, 2580.
13. Brit. J. Phot. 1903, **50**, 98.
14. Phot. Korr. 1906, **43**, 342.
15. Brit. J. Phot. 1880, **27**, 454.
16. Mon. Phot. 1878, **17**, 137.
17. See Phot. News, 1885, **29**, 338; 1886, **30**, 677; 1893, **37**, 90. Brit. J. Phot. 1877, **24**, 334; 1905, **52**, 565, 566; 1906, **53**, 147; 1909, **56**, 557. Jahr. Phot. 1893, **7**, 403; 1894, **8**, 390, 391, 406; 1895, **9**, 250; 1908, **22**, 200. Phot. Annual, 1898, 218.
18. Jahr. Phot. 1908, **20**, 511.
19. Jahr. Phot. 1909, **23**, 371; Brit. J. Phot. Suppl. 1907, **1**, 88.

of Meydenbauer,¹ the latter having been extensively used.

In connection with the above, J. Eder² has laid down certain conditions for color sensitizing which have become generally accepted as correct, and among which may be mentioned:

1. The dyes must stain the silver halide grain, and are preferably direct or substantive colors.³

2. A dye sensitizes for those rays which the dyed silver halide absorbs, the maximum sensitiveness being in about the same position as the maximum absorption of the dye, with a general shift towards the red, i. e., the maximum sensitiveness agrees with the maximum absorption of the silver halide.

3. Dyes with narrow, intense absorption bands give correspondingly intense sensitizing bands, and conversely. The brilliancy of color of the dye has no special significance.

4. Neither the fugitive character of the dye nor its fluorescence has any action on the color sensitizing properties.⁴

The physics and mathematics of the above is a topic beyond the scope of this review.⁵

E. Vogel⁶ examined the sensitizing action of fluorescent dyes and found that fluorescence and sensitization are not complementary, although Stark⁷ considers the sensitizing as directly produced by the fluorescence of one dye molecule adherent to one silver halide molecule, but E. Wall and Kayser⁸ have shown the improbability of the above theory. With reference to the instability of the dye, A. v. Hübl has shown⁹ that the first condition for efficiency is that it must in itself suffer decomposition by light (must be unstable) and that the silver bromide undergoes a change,

1. Phot. News, 1880, **33**, 356.

2. Handb. Phot. 1905, **3**, 105; Beiträge z. Photochem. u. Spektralanalyse, 1904, **3**, 1.

3. E. Wall, Brit. J. Phot. 1907, **54**, 365, 386, 406, 464.

4. See Eder Handb. Phot. 1895, **3**, 189; 1903, **3**, 128. Jahr. Phot. 1894, **8**, 149. Lüppo-Cramer, Wiss. Arbeit. Phot. 1902, 65. Kieser, Beiträge z. Chem. opt. Sensibilisation v. Silbersalzen, Freiburg, 1904. Günther, Phot. Chron. 1905, No. 57 and 59. Wentzel, Beiträge zur optischen Sensibilisation der Chlorsilbergelatine, 1908. Jahr. Phot. 1903, **17**, 128.

5. Lüppo-Cramer, Jahr. Phot. 1902, **16**, 57. Regarding the validity of Kundt's law see Shephard, Photo-Chemistry, 1914, 151.

6. Wied. Ann. Phys. 1891, **43**, 449, 472. Kayser's Handb. Spektroskopie, 1908, **4**, 1008.

7. Physik. Zts. 1907, **8**, 248; Brit. J. Phot. 1907, **54**, Suppl. **1**, 44.

8. See Handb. Spektroskopie, 1908, **4**, 1008.

9. "Die Collodium-Emulsion," 1894, 76. Klein, "Collodium Emulsion," 1906, 19.

not only under the blue, but also under the less refrangible rays.

The preponderance of evidence, however, appears to be against v. Hübl and in favor of J. Eder.¹ Bothamly,² J. Eder,³ and Mees and Sheppard⁴ have gone into this subject thoroughly. v. Hübl rightly points out⁵ that silver halides exhibit a marked difference in their behavior to sensitizers, J. Eder⁶ being the first to demonstrate the favorable action of silver chloride. The question of suitability of a particular dyestuff for this purpose can only be determined by practical trial.⁷

Of the older dyestuffs, the bluish eosine (dibromdinitrofluorescein), cyanine (chinoline blue or quinoline blue, iodoamylcyanine),⁸ are, perhaps, the more valuable. Other dyestuffs which have been favorably used for this purpose include Canary II, Diamond black PV,⁹ ethyl violet (hexaethyl-*p*-rosaniline),¹⁰ quinoline red,¹¹ and the newer isocyanine dyes,¹² which include ethyl red, pinaverdol, orthochrome T, pinachrome, pinacyanol, homocol, isocol, diecyanin and pinachrome violet.

*Light Filters or Color Screens.*¹³ Collodion has been exten-

1. See Translation of Eder's treatise on "the Chemical Effect of Spectrum," Phot. J. 1881-1882; published as a book, 1883. See also E. Wall, Brit. J. Phot. 1907, **54**, 407.

2. Brit. J. Phot. 1895, **42**, 727; Jahr. Phot. 1896, **10**, 167. Beitrage z. Photochem. u. Spektralanalyse, 1904, **3**, 100, Brit. Assoc. Rep. 1895, 66, Chem. News, 1895, **72**, 187. Phot. Annual, 1896, 168.

3. Beitrage z. Photochem. u. Spektralanalyse, 1900, **3**, 100.

4. Phot. J. 1906, **53**, 129.

5. "Die Collodium-Emulsion," 1894, 73.

6. Phot. Korr. 1884, 143.

7. In this connection refer to H. Vogel, "Die Photographie farbiger Gegenstände," 1885, 10. J. Eder, Phot. Korr. 1884, 143. Beitrage z. Photochem. u. Spektralanalyse, 1904, **3**, 91.

8. See J. Eder, Phot. Korr. 1891, 313. Koenig, Jahr. Phot. 1903, **17**, 9.

9. See Klein, "Collodion Emulsion," 1905, 25.

10. Valenta, Phot. Korr. 1901, 37.

11. See H. Vogel, D. R. P. 39772, 1886.

12. Miethe and Traube, D. R. P. 142026; U. S. P. 724311. See also D. R. P. 158080, 179049, 170048, 158078; U. S. P. 752323. D. R. P. 170049, 218904, 24317, 176159, 172118, 175034, 178688, 189942, 155541, 154448. See also Harrison and Bottomley, J. Soc. Dyers Col. 1917, **33**, 179; Color Trade J. 1918, **2**, 229. Adams and Wise, U. S. P. 1338349, 1338346. Pope and Mills, Phot. J. 1920, **60**, 183. Koenig, Photochemie, 1906, 320; Phot. Korr. 1903, 479; Jahr. Phot. 1903, **17**, 10, 306, 438, 440; 1904, **18**. A. Newton and A. Bull, Phot. J. 1904, **45**, 15. Klein, Collodion Emulsion, 1905, 24.

13. For general data see Brit. J. Phot. 1871, **18**, 306; 1899, **46**, 198; 1904, **51**, 391. Phot. News, 1887, **31**, 97; 1890, **34**, 271. Jahr. Phot. 1893, **7**, 405; 1895, **9**, 359; 1898, **12**, 346. Photography, 1890, **2**, 522, 650; 1903, **15**, 89. Wilson's Phot. Mosaics, 1896, 105. Phot. Record, 1891-1894, **2**, 210. W. Abney, Phot. Annual, 1889, 378.

sively used in the production of yellow filters, i. e., filters to cut out the violet and ultraviolet rays. In general a plain collodion is employed in which certain yellow dyestuffs are dissolved, curcuma and curcumin,¹ chrysoidin,² aurine,³ aniline yellow, naphthol yellow, brilliant yellow, multiple yellow,⁴ Brazil wood,⁵ saffron and safflower,⁶ and aurantia⁷ having been used, although, in respect to the latter, acridine yellow or tartrazine have been found more satisfactory.

In the ray filter of W. Aarland,⁸ colored celluloid substances are dissolved in glycerol and imbedded in a vessel with parallel walls. The L. Geisler reflecting color filter for photographic polychrome cameras,⁹ consists of a thin collodion membrane. R. Artlett¹⁰ employs two glass discs coated with colored collodion. T. Willsie,¹¹ G. Selle,¹² and E. Oeser¹³ have patented collodion filters for this purpose.

Color Photography.¹⁴ It was in 1861 that the first suggestion as to the production of photographic pictures in the colors of nature was made by J. Maxwell,¹⁵ while four years later, H. Collier¹⁶

1. W. Elliot, *Brit. J. Phot.* 1866, **13**, 542.

2. C. Bardy, *Phot. News*, 1877, **21**, 362. J. Eder and Toth, *Phot. News*, 1879, **23**, 344. See also *Phot. News*, 1899, **43**, 349.

3. A. Brown, *Phot. News*, 1881, **25**, 357.

4. J. Baldock, *Brit. J. Phot.* 1899, **46**, 87.

5. M. Haugk, *Phot. News*, 1870, **14**, 386.

6. *Phot. News*, 1861, **5**, 208.

7. See *Phot. News*, 1890, **34**, 538, 1897, **41**, 261; 1900, **44**, 271, 1901, **45**, 494; 1905, **49**, 69.

8. D. R. P. 144661; *abst. Wag. Jahr.* 1903, **49**, 11, 547.

9. D. R. P. 246939, 1910; *abst. C. A.* 1912, **6**, 2583.

10. E. P. 27373, 1898.

11. U. S. P. 727524, 1903.

12. D. R. P. 124624. E. P. 12515, 1899.

13. D. R. P. 209366. For a discussion of collodion safe lights for dark-room illumination see *Brit. J. Phot.* 1911, **58**, 474, 628.

14. In this connection the following references may also prove of interest: D. Barbieri, *Brit. J. Phot.* 1900, **47**, 474. J. Husnik, *Phot. News*, 1878, **22**, 148. H. Gunther, *Phot. News*, 1890, **34**, 357. M. Geymet, *Phot. News*, 1874, **18**, 571, 581. F. Hollingsworth, *Photography*, 1903, **15**, 105. A. Hubl, *Brit. J. Phot.* 1897, **44**, 293. A. Newton, *Brit. J. Phot.* 1908, **55**, 257. A. Streissler, *Phot. Rundschau*, **25**, 150. J. Sawyer, *Phot. News*, 1883, **27**, 349. T. Sims, *Phot. News*, 1876, **20**, 291. E. Valenta, *Chem. Ztg.* 1910, **34**, 713, 722; 1911, **35**, 941; *abst. C. A.* 1911, **5**, 3543. H. Vogel, *Phot. News*, 1877, **21**, 585. V. Vaucamps, *Brit. J. Phot.* 1897, **44**, 712. O. Witt, *D. R. P. Anm. W.* 14564, 1893. Anon., *Phot. News*, 1878, **22**, 116, 1894, **38**, 248; 1906, **50**, 976, 1020, 1040. *Brit. J. Phot.* 1868, **15**, 467; 1873, **20**, 587; 1897, **44**, 310; 1898, **45**, 133; 1909, **56**, 7.

15. *Proc. Roy. Soc.* 1859-1860, **10**, 404, 484; *Phil. Trans.* 1860, 57; *Brit. J. Phot.* 1861, **5**, 272; *Phot. News*, 1861, **5**, 374.

16. *Brit. J. Phot.* 1865, **12**, 547.

suggested the use of three positives in red, yellow and blue, superimposed on paper. Baron Ronsonnel¹ also attempted to produce three colors in a somewhat similar manner. L. Ducos du Hauron² obtained patents for a three-color system, and C. Cros³ deposited in 1877 a sealed communication as to the details of his process, but it was not until 1873 that H. Vogel discovered the principle of orthochromatizing emulsions, that serious advancement was made.

Screen Plates. In the preparation of polychromatic grain screen plates, and C. Brasseur⁴ sprinkles minute grains stained with the fundamental colors on an adhesive surface. Akt. Ges. f. Anilin-Fabrikation spray colored solutions,⁵ while W. Aarland⁶ mixes colored celluloid substances. J. Bamber⁷ colors grain of sandarac; A. Baumgartner⁸ applies the colors alternately to the celluloid matrix; while Gebrüder Baldauf,⁹ R. Berthon and J. Gambs,¹⁰ and C. Brasseur¹¹ weld alternate colorless and colored layers together by means of a solvent. J. Christensen¹² dyes shellac separately with the primary colors and applies; E. Caille,¹³ E. Clifton and A. Wells,¹⁴ and B. Cooper¹⁵ contributed.

L. Dufay¹⁶ makes homogeneous polychrome screens for color

1. Phot. Korr. 1869, 199, 333.
2. F. P. 83061, 1868. E. P. 2793, 1876.
3. Bull. Soc. Franc. Phot. 1869, 177; Brit. J. Phot. 1879, **26**, 136.
4. D. R. P. 219663, 219977; abst. Wag. Jahr. 1910, **56**, II, 534.
5. D. R. P. 261341, 1911; abst. C. A. 1913, **7**, 3727. E. P. 9167, 1912; abst. C. A. 1913, **7**, 3722.
6. D. R. P. 144061; abst. Wag. Jahr. 1903, **49**, II, 547.
7. E. P. 3252, 1908; 11147, 1909; 15755, 1911; abst. J. S. C. I. 1908, **27**, 1132; 1909, **28**, 1064; 1912, **31**, 844; C. A. 1913, **7**, 30; Brit. J. Phot. 1909, **56**, 730.
8. E. P. 22138, 1895; abst. Brit. J. Phot. Suppl. 1907, **1**, 32.
9. D. R. P. 120870, 1900; abst. Wag. Jahr. 1901, **47**, II, 610.
10. E. P. 20834, 1906; abst. Brit. J. Phot. 1907, **54**, 603. E. P. 10611, 1909. See Phot. Ind. 1910, 337.
11. U. S. P. 974464. E. P. 21210, 1904. E. P. 18750, 1908; abst. J. S. C. I. 1909, **28**, 259; Brit. J. Phot. 1909, **50**, 145. E. P. 20909, 1908; 28631, 1913; abst. J. S. C. I. 1915, **34**, 303; Ann. Rep. Soc. Chem. Ind. 1916, **1**, 305. D. R. P. 219663; abst. Wag. Jahr. 1910, **56**, II, 534.
12. E. P. 20971, 1908; abst. Brit. J. Phot. 1909, **56**, 269. E. P. 7480, 1912. E. P. 25419, 1913; abst. J. S. C. I. 1913, **32**, 1226. E. P. 13260, 1914; 25419, 1913; abst. C. A. 1915, **9**, 1282.
13. F. P. 445787, 1912 and addn. dated July 6, 1912 thereto; abst. J. S. C. I. 1912, **31**, 1202; 1913, **32**, 1033.
14. E. P. 23615, 1907; 23273, 1908.
15. E. P. 22193, 1906; abst. Brit. J. Phot. 1907, **54**, 677.
16. U. S. P. 1003720, 1911; abst. J. S. C. I. 1911, **30**, 1232; C. A. 1911, **5**, 3768. E. P. 18744, 1908; 15027, 27708, 1912. F. P. 442881, 1911 and addn. dated Dec. 2, 1911 thereto; abst. J. S. C. I. 1912, **31**, 1008; 1913, **32**,

photography by covering in lines of greasy substance the surface of a layer of transparent material so as to leave free the surface to receive the first tint, coloring this portion, covering the whole with a varnish having a resinous base which only adheres to the colored part so as to protect it from subsequent coloration. Then making a second similar application of greasy material in lines crossing the lines of the first application, and thus continuing with the application of the third color. The Dufay processes contain many elements of novelty and merit. The Deutsche Raster Ges.,¹ O. and H. Dawson,² and F. Dyer,³ have also been granted patent protection.

The G. Eastman film⁴ embodies in a single structure a transparent support having minute differently colored transparent areas, a sensitized emulsion, and a uniformly stained transparent coating constituting a ray filter, which is located in front of the colored areas during exposure. C. Finlay,⁵ and F. Fifield,⁶ have also described color screen plates. F. Fritz⁷ produces line screens from colored fabrics of colored artificial fibers which soften on heating, as celluloid. A. Granger⁸ has detailed a useful summary of the art, including the manipulation of autochrome and omnichrome plates.⁹ The color-carrier of I. Kitsee,¹⁰ and the celluloid color screen of R. Liesegang¹¹ deserve mention. The so-called "auto-chrome" process of A. and L. Lumière,¹² comprizes the use

451. Swiss P. 43193, 1908. For a review of the relative merits of the Dufay dioptrichrome screen color plate see F. Limmer, *Phot. Rundschau*, **24**, 105, *Wiener Mitth.* **15**, 178. R. Guilleminot and E. Boespflug, *Bull. Soc. Franc. Phot.* **25**, 329. H. Hinterberger, *Wiener Mitth.* **14**, 583, abst. C. A. 1910, **4**, 870. *Brit. J. Phot.* 1908, **55**, Suppl. 46. See also F. Dogilbert, *Brit. J. Phot.* 1911, **58**, Suppl. 4.

1. E. P. 26911, 1909. D. R. P. 188431, 189026, 190500. Swiss P. 42903, 1908.

2. E. P. 6903, 1913; abst. C. A. 1914, **8**, 2086; J. S. C. I. 1913, **32**, 990.

3. U. S. P. 947965, 1910; abst. C. A. 1910, **4**, 1137.

4. U. S. P. 1028337, 1912; abst. C. A. 1912, **6**, 2582.

5. E. P. 19662, 1906; abst. *Brit. J. Phot.* 1907, **54**, 737.

6. U. S. P. 990247, 1911; abst. C. A. 1911, **5**, 2224.

7. D. R. P. 218324, 1908; 223819; abst. J. S. C. I. 1910, **29**, 977. D. R. P. 227130, 1908; abst. J. S. C. I. 1910, **29**, 1410. D. R. P. 231676, 1910; abst. *Wag. Jahr.* 1911, **57**, II, 510; *Zts. ang. Chem.* 1911, **24**, 659; C. A. 1912, **6**, 1717.

8. *Mon. Sci.* 1909, **70**, 361.

9. For "Omnichrome" plates see M. Jougla, *Bull. Soc. Franc. Phot.* **25**, 199. F. Limmer, *Phot. Rundschau*, **23**, 120; *Phot. Chron.* **15**, 227.

10. U. S. P. 1221457, 1917.

11. D. R. P. April 6, 1899.

12. U. S. P. 822532, 1906; 877351, 1908. E. P. 7188, 1895. E. P.

of stained starch granules, or similar spherical particles.

R. Krayn made several disclosures of real merit in the evolution of his celluloid screen.¹ He produced colored photographic screens, prepared by building up the layers with thin transparent celluloid sheets colored and cemented together with a uniform sequence of colors until the required thickness is obtained for cutting transverse sections. A. Lederer used water soluble dyes not soluble in alcohol; while F. Lehner² and A. Lehner,³ working independently, also specified special dyestuffs adapted to this purpose. The H. Hamblin⁴ and C. Hollborn⁵ processes are similar.

L. du Hauron and R. de Bercegol,⁶ and J. McDonough⁷ evolved a light filter of movable transparent celluloid plates which can completely close the aperture of the lens hood or diaphragm, or can allow some unfiltered light to pass. F. Limmer described⁸ and the Miley Color Photograph Co.⁹ prepared separate pigment photographs on bichromated gelatin films having inert red, yellow and blue pigments respectively which have a color value of substantially that of the primary color it represents. The A.

22988, 1904; F. P. 339233, 1904; abst. J. S. C. I. 1905, **24**, 104, 249. F. P. 350004, 1904. Compt. rend. 1904, **138**, 1337. Bull. Soc. Franc. Phot. 1901, (2), **17**, 411.

1. U. S. P. 728245, 1903; 1055189, 1913. E. P. 13093, 1902; abst. J. S. C. I. 1903, **22**, 923. E. P. 19202, 1905; 1938, 1906; abst. Brit. J. Phot. 1906, **53**, 534. E. P. 58, 495, 1907; 2213, 1908; 18553, 26911, 1909; 22938, 1913; abst. J. S. C. I. 1914, **33**, 1116. F. P. 357896 and additions 6534, 6536 thereto. D. R. P. 167232, 167613, 188451, 190560. Belg. P. 193681, 193682, 193683, 1906; 218393, 1909. For discussion of these patents see also Brit. J. Phot. 1908, **55**, Suppl. 23. H. Quentin, Bull. Soc. Franc. Phot. (3), **2**, 293; abst. C. A. 1911, **5**, 3766. E. Valenta, Brit. J. Phot. Suppl. 1911, **58**, 30. C. Breuer, Kunst. 1911, **1**, 229. W. Scheffler, Brit. J. Phot. Suppl. 1910, **57**, 89.

2. E. P. 7269, 1908; abst. J. S. C. I. 1909, **28**, 109; Brit. J. Phot. 1909, **56**, 49.

3. U. S. P. 1113359. U. S. P. 112540, 112541; abst. C. A. 1914, **8**, 3763.

4. E. P. 6279, 1911; abst. Brit. J. Phot. 1912, **59**, 204.

5. D. R. P. 247722, 1909; abst. C. A. 1912, **6**, 2583; Zts. ang. Chem. 1912, **25**, 1741.

6. U. S. P. 995405, 1005644, 1911. E. P. 194, 1907; abst. Brit. J. Phot. 1907, **54**, 696. See also Brit. J. Phot. Suppl. 1907, **1**, 13.

7. U. S. P. 471186, 1892. See also E. P. 13895, 1896.

8. This writer has reviewed most of the processes described therein: Phot. Rundschau, **23**, 297; **24**, 143; Phot. Korr. **46**, 373; Phot. Chron. **17**, 541; Zts. ang. Chem. 1909, **22**, 14.

9. F. P. 324813, 1902; E. P. 17485, 1902; abst. J. S. C. I. 1902, **21**, 1411; 1903, **22**, 649. U. S. P. 711875, 1902.

Pierman multicolor screen¹ is composed of colored strands woven together in a regular pattern and embedded in a thin, transparent, flexible ribbon by soaking the screen in a collodion solution. H. Palmer² mechanically prints the colors in points or squares by successive impressions from a single block, so that no two squares of any one color come next to each other. The methods of J. and E. Rheinberg,³ J. Rey,⁴ J. Rieder,⁵ R. Ruth,⁶ R. Raymond,⁷ and M. Ratignier and H. Pervilliac⁸ involve similar ideas.

S. Sheppard⁹ forms dyed photographic plates in which the edge is fixed in a medium from which it will not run, the dye being mixed with a nitrocellulose solution in amyl acetate. In another method¹⁰ a glass plate is supplied with a film of celluloid on which are ruled two sets of lines at right angles to each other in different colored inks. When these are dry, the film is stained with a solution of the third dyestuff in a solvent of the celluloid. A. Schwartz,¹¹ and especially A. Lumière¹² dye starch granules which are interspersed in the correct ratio in the collodion or gelatin substance.

J. Szczepanik¹³ employs a direct process in which plates with a mosaic-like colored layer are used. C. Spath¹⁴ manufactures

1. U. S. P. 1196718, 1916; abst. J. S. C. I. 1916, **35**, 1035.
2. E. P. 17309, 1908; abst. Brit. J. Phot. 1909, **56**, 689. E. P. 16313, 1909; 8761, 1910; F. P. 431991, 1911; abst. J. S. C. I. 1911, **30**, 921, 1170. E. P. 6279, 1911; abst. J. S. C. I. 1912, **31**, 302. C. A. 1912, **6**, 2582.
3. E. P. 22938, 1913; abst. J. S. C. I. 1914, **33**, 1116.
4. Belg. P. 206691, 1908.
5. Phot. Rundschau, **24**, 151. (Description of the "Askani" process.)
6. E. P. 19554, 1910; abst. J. S. C. I. 1911, **30**, 650.
7. Brit. J. Phot. 1908, **55**, 97.
8. F. P. 391785, 1907; abst. J. S. C. I. 1908, **27**, 1178.
9. U. S. P. 1290794, 1919; abst. C. A. 1919, **13**, 818, J. S. C. I. 1919, **38**, 200-A.
10. Soc. Anon. des Plaques, Pellicules, et Papiers Photographiques J. Jouglé, L. du Hauron and R. de Bercegol, F. P. 387828, 1907; abst. J. S. C. I. 1908, **27**, 877.
11. E. P. 28614, 1907; abst. Brit. J. Phot. 1908, **55**, 874.
12. Soc. anon. des Plaques et Papiers Photographiques A. Lumière et ses Fils, E. P. 22988, 1904; abst. J. S. C. I. 1905, **24**, 104. E. P. 29273, 1909. F. P. 393290, 1907; 425580, 1910; abst. J. S. C. I. 1909, **28**, 109. D. R. P. 172851, 1904; abst. Chem. Centr. 1906, **77**, 11, 1027.
13. U. S. P. 1089602; abst. C. A. 1914, **8**, 1551. E. P. 6098, 1907, 17065, 1908; abst. Brit. J. Phot. 1908, **55**, 873. See also F. Limmer, Brit. J. Phot. Suppl. 1909, **3**, 49.
14. U. S. P. 1069039; abst. J. S. C. I. 1913, **32**, 885; C. A. 1913, **7**, 3086. U. S. P. 1081341; abst. C. A. 1914, **8**, 470. E. P. 23138, 1910; abst. J. S. C. I. 1911, **30**, 109; Brit. J. Phot. 1911, **58**, 30. F. P. 421119, 1910. Swiss P. 46193, 1909. D. R. P. 239486, abst. Wag. Jahr. 1911, **57**, 11, 511, Zts. ang. Chem. 1911, **24**, 2178; C. A. 1912, **6**, 2042.

color screens on celluloid films with a resist, acting on the unprotected portion with acetone and alcohol, and then with a dye solution containing a colloid. J. Smith,¹ E. Longer-Shepherd,² M. Ungerer,³ and O. Witt⁴ have made suggestions. The Vereinigte Kunstseidefabriken⁵ as well as G. Whitfield,⁶ E. Wall⁷ and M. Wieland⁸ have approached the subject from new angles. The Warner-Powrie⁹ process and the writings of E. Stenger,¹⁰ J. Stark,¹¹ P. Pooth¹² and W. Scheffer¹³ mark distinct efforts in advancement.

Color Cinematography. The principles of color photography as previously touched upon have been carried a step further in endeavors to produce continuous photographic films in natural colors. The details of this complex subject are to be found in the patents and writings of P. Ulysse,¹⁴ the phototypoglyphie of Societe Sohler et Cie,¹⁵ E. J. Wall,¹⁶ A. Hernandez-Mejia,¹⁷ C. Christensen,¹⁸ J. Thornton,¹⁹ J. Campbell and T. Thompson,²⁰

1. E. P. 19940, 1904; 129717, 1917; abst. J. S. C. I. 1919, **38**, 696-A; C. A. 1919, **13**, 2818.
2. E. P. 20384, 1907; abst. Brit. J. Phot. 1908, **55**, 459.
3. E. P. 17079, 1913; abst. J. S. C. I. 1914, **33**, 916.
4. D. R. P. Ann. W.-14564.
5. E. P. 7739, 21839, 21840, 1908; abst. J. S. C. I. 1909, **28**, 627; Brit. J. Phot. 1909, **56**, 146, 426. F. P. 380134; 395164, 1908; abst. J. S. C. I. 1909, **28**, 329. D. R. P. 197749; 218298; abst. Wag. Jahr. 1910, **56**, II, 532.
6. E. P. 9044, 9693, 1908; abst. Brit. J. Phot. 1909, **56**, 425.
7. E. P. 1372, 1908; abst. Brit. J. Phot. 1908, **55**, 103.
8. E. P. 137502, 1919; abst. J. S. C. I. 1920, **39**, 248-A; C. A. 1920, **14**, 1268.
9. For a description of this process see E. Grills, Brit. J. Phot. 1907, **54**, 763. A. Newton, Brit. J. Phot. 1907, **54**, 730. E. Wall, Brit. J. Phot. 1907, **54**, 707.
10. Atelier Phot. **18**, 97, 107, 122; abst. C. A. 1912, **6**, 459.
11. Physik. Zts. 1907, **8**, 81; Brit. J. Phot. Suppl. 1907, **54**, 46.
12. Technik u. Ind. 1919, 143; abst. C. A. 1920, **14**, 1644.
13. Bull. Soc. Franc. Phot. (3), **1**, 70; Brit. J. Phot. Suppl. 1910, **57**, 89; abst. C. A. 1910, **4**, 1851.
14. D. R. P. 259136, 1910; abst. C. A. 1913, **7**, 3087.
15. D. R. P. 237601, 1909; abst. C. A. 1912, **6**, 1890.
16. E. P. 23551, 1911; abst. Brit. J. Phot. 1912, **59**, 904.
17. Brit. J. Phot. 1912, **59**, 805.
18. E. P. 2218, 1912; abst. Brit. J. Phot. 1912, **59**, 789.
19. U. S. P. 1281714; abst. C. A. 1919, **13**, 99. E. P. 3385, 29112, 1912. F. P. 459122, 459123, 459124, 1913.
20. E. P. 23386, 1911; abst. J. S. C. I. 1912, **31**, 258. E. P. 21261, 1911; abst. Brit. J. Phot. 1912, **59**, 541. E. P. 23497, 1911; abst. Brit. J. Phot. 1912, **59**, 1000. E. P. 23499, 1911; abst. Brit. J. Phot. 1912, **59**, 885. E. P. 24646, 1911; abst. Brit. J. Phot. 1912, **59**, 925. E. P. 1489, 1912; abst. Brit. J. Phot. 1912, **59**, 866. E. P. 7477, 1912.

L. Herzberg,¹ J. Szczepanik,² Saunders and Wellesley,³ P. Brewster,⁴ W. Featherstone,⁵ J. Lasky⁶ and R. Berthon.⁷

Subtractive Films or transferences with color films one on top of the other, the so-called newer photographic transfer processes, is a broad subject with many angles and difficult of abstraction without embodying details, for many processes imperceptibly blend into others with the exception of apparently unimportant methods of manipulation. The subject in general will be found unfolded in the communications and patented processes of A. G. f. Anilinfabrikation,⁸ P. Brewster,⁹ R. Berthon,¹⁰ C. Brasseur,¹¹ A. Braham,¹² H. Bonneville,¹³ G. Bauge, A. Dumez and A. Seauve,¹⁴ R. Bradshaw and J. Lyell,¹⁵ J. Campbell and T. Thompson,¹⁶ Chem. Fabrik auf Actien vorm. E. Schering,¹⁷ C. Courmont,¹⁸ J. Crabtree,¹⁹ J. Capstaff,²⁰ J. T. Clarke,²¹ E. Clarke,²² J. Christensen,²³ E. Clifton,²⁴ E. Donisthorpe,²⁵ C. Dicker,²⁶ A. Davies,²⁷ L. Errera,²⁸

1. E. P. 14133, 1912.
2. U. S. P. 1089602; abst. C. A. 1914, **8**, 1551. See also E. P. 7729, 1899; abst. Brit. J. Phot. 1900, **47**, 328.
3. E. P. Appl. 4053, 1919; abst. J. S. C. I. 1919, **38**, 162-A.
4. U. S. P. 1145968; abst. C. A. 1915, **9**, 2355.
5. E. P. 18352, 1911; abst. Brit. J. Phot. 1912, **59**, 733.
6. E. P. 126745, 1917; abst. J. S. C. I. 1919, **38**, 479-A.
7. E. P. 10611, 1909; abst. J. S. C. I. 1910, **29**, 720.
8. E. P. 925, 1904; F. P. 365314, 1906. In this connection see also Brit. J. Phot. 1899, **46**, 471, 540; 1900, **47**, 572; Suppl. 5, 1902, **49**, 52, 1908, **55**, Suppl. 12, 20. Phot. News, 1907, **51**, 505. A. Graby, Bull. Soc. Franc. Phot. 1896, (2), **12**, 481. L. du Hauron, Bull. Soc. Franc. Phot. 1896, (2), **12**, 473. J. S. C. I. 1902, **49**, 52.
9. U. S. P. 1308538; abst. C. A. 1919, **13**, 2166. U. S. P. 1145968, 1915; abst. C. A. 1915, **9**, 2355.
10. E. P. 10611, 1909; abst. J. S. C. I. 1910, **29**, 720.
11. E. P. 21210, 1904; abst. J. S. C. I. 1905, **24**, 1190.
12. Brit. J. Phot. 1906, **53**, 560.
13. E. P. 5522, 1881.
14. E. P. 20251, 1911; abst. Brit. J. Phot. 1912, **59**, 979.
15. U. S. P. 1139633; abst. C. A. 1915, **9**, 1723.
16. E. P. 7477, 1912.
17. E. P. 22725, 1905; abst. J. S. C. I. 1906, **25**, 1067. F. P. 366314, 1906; abst. J. S. C. I. 1906, **25**, 953.
18. E. P. 16201, 1911; abst. J. S. C. I. 1912, **31**, 844.
19. U. S. P. 1305962; abst. C. A. 1919, **13**, 2166.
20. U. S. P. 1303635, 1919; abst. J. S. C. I. 1919, **38**, 513-A.
21. E. P. 10951, 1904; abst. Brit. J. Phot. 1905, **52**, 335.
22. E. P. 9184, 1902; abst. J. S. C. I. 1903, **22**, 511.
23. F. P. 481149, 1916; abst. J. S. C. I. 1917, **36**, 164. E. P. 25419, 1913.
24. U. S. P. 923019, 1909; E. P. 23615, 1907; abst. Brit. J. Phot. 1909, **56**, 163.
25. E. P. 5641, 1908; abst. J. S. C. I. 1909, **28**, 491; Brit. J. Phot. 1909, **56**, 310.

- *J. Eder,¹ F. Fritz,² W. Fox, W. Hickey and Kinemacolor Co.,³ L. Garchey,⁴ E. Grills,⁵ A. Gurtner,⁶ F. Ives,⁷ The Hess-Ives Co.,⁸ H. Jorelle,⁹ F. Kent,¹⁰ A. and L. Lumière,¹¹ Miley Colour Photograph Co.,¹² T. Middleton, F. Kent and W. Ferguson,¹³ V. Mathieu,¹⁴ S. Manners,¹⁵ J. Rieder,¹⁶ G. Selle,¹⁷ J. H. Smith,¹⁸ J. H. Smith and W. Merckens,¹⁹ L. Smith,²⁰ E. Sanger-Shepherd and O. Bartlett,²¹
26. E. P. 17167, 1898; abst. J. S. C. I. 1899, **18**, 732.
 27. E. P. 18741, 1906; abst. Brit. J. Phot. 1907, **54**, 603.
 28. E. P. 20660, 1898; abst. Brit. J. Phot. Suppl. 1907, **1**, 47.
 1. Phot. Korrr. 1919, **56**, 140; Chem. Zentr. 1919, **90**, IV, 396; abst. J. S. C. I. 1919, **38**, 878-A.
 2. D. R. P. 218324; abst. Wag. Jahr. 1910, **56**, II, 533.
 3. E. P. 8728, 1914; abst. J. S. C. I. 1914, **33**, 1227.
 4. E. P. 19843, 1899; abst. Brit. J. Phot. Suppl. 1907, **1**, 64.
 5. Brit. J. Phot. Suppl. 1907, **1**, 17.
 6. U. S. P. 730454, 1903; abst. J. S. C. I. 1903, **22**, 820. See also Phot. News, 1906, **50**, 11.
 7. U. S. P. 927244, 1909; 960939, 1910; 1145143; abst. C. A. 1915, **9**, 2355. U. S. P. 1170540; abst. J. S. C. I. 1916, **35**, 386. U. S. P. 1173429; abst. J. S. C. I. 1916, **35**, 490. U. S. P. 1240344; abst. C. A. 1917, **11**, 3182. U. S. P. 1248804, 1917; abst. J. S. C. I. 1918, **37**, 75-A. U. S. P. 1300616, 1919; E. P. 113617, 1918; abst. J. S. C. I. 1918, **37**, 607-A; 1919, **38**, 479-A. U. S. P. 1306904; abst. J. S. C. I. 1919, **38**, 2166; J. S. C. I. 1919, **38**, 602-A. E. P. 14243, 1909; 21410, 1910; 17799, 1913. F. P. 463737, 1913; E. P. 15823, 1913; abst. J. S. C. I. 1914, **33**, 441; Ann. Rep. Soc. Chem. Ind. 1916, **1**, 307. See also Phot. News, 1900, **44**, 764, 781, 795, 809, 842. Brit. J. Phot. 1911, **58**, Suppl. 19. J. S. C. I. 1910, **29**, 542.
 8. E. P. 113618, 1918; U. S. P. 1278667, 1918; abst. J. S. C. I. 1918, **37**, 784-A; 1919, **38**, 200-A. E. P. 119854, 1918; U. S. P. 1278668, 1918; abst. J. S. C. I. 1918, **37**, 784-A; 1919, **38**, 554-A. F. P. 461078, 1913; abst. J. S. C. I. 1914, **33**, 44.
 9. F. P. 460724, 1912; abst. Mon. Sci. 1914, **81**, 130.
 10. E. P. 20555, 20556, 1912; abst. J. S. C. I. 1913, **32**, 990. E. P. 29616, 1912; abst. J. S. C. I. 1914, **33**, 221. E. P. 12091, 1915.
 11. E. P. 7188, 1895; abst. J. S. C. I. 1895, **14**, 417; 1896, **15**, 68, 214.
 12. E. P. 17485, 1902; abst. Brit. J. Phot. 1907, **54**, 80; J. S. C. I. 1902, **21**, 1411. F. P. 324813, 1902; abst. J. S. C. I. 1903, **22**, 649.
 13. Phot. J. 1919, **59**, 42; abst. C. A. 1919, **13**, 3094.
 14. E. P. 17758, 1894; abst. Brit. J. Phot. Suppl. 1907, **1**, 16.
 15. E. P. 25646, 1910; abst. Brit. J. Phot. 1911, **58**, 46.
 16. Phot. Rundschau, **23**, 257; **24**, 151. (Described prints by the "Askau" process)
 17. E. P. 7104, 1895; abst. Brit. J. Suppl. 1907, **1**, 24. E. P. 4290, 1899; abst. Brit. J. Phot. Suppl. 1900, **47**, 23; 1907, **54**, 48. E. P. 12515, 1899; abst. Brit. J. Phot. 1900, **47**, 539. E. P. 12516, 12517, 1899. E. P. 8498, 1903; abst. Brit. J. Phot. Suppl. 1907, **1**, 88. Belg. P. 169728, 1903. D. R. P. 101132, 1895; abst. Chem. Centr. 1899, **70**, I, 911. D. R. P. 168124, 1905; abst. Zts. ang. Chem. 1906, **19**, 2003. See also Phot. News, 1898, **42**, 329. Swiss P. 27940, 1903. Brit. J. Phot. 1896, **44**, 6.
 18. U. S. P. 781469, 1905; 886883, 1908. E. P. 19940, 1904; abst. Brit. J. Phot. Suppl. 1907, **1**, 96. Belg. P. 179515, 1904. Swiss P. 29446, 33594, 35228. See also Phot. News, 1906, **50**, 351.
 19. E. P. 7217, 1907; abst. J. S. C. I. 1907, **26**, 1109. Belg. P. 197512, 1907. Swiss P. 40060, 1909. D. R. P. 223767; abst. Chem. Zentr. 1910, **81**, II, 527. See also J. H. Smith and N. Stafford, D. R. P. 223195; abst. Chem.

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A. Tauleigne and E. Mazo,⁴ M. Ungerer,⁵ E. J. Wall,⁶ W. White,⁷
M. Wolff,⁸ and G. Woodiwiss.⁹

In the G. Lippmann process of interference heliochromy¹⁰ cellulose is dissolved in Schweizers solution, coated on a glass plate, decolorized with HCl, sensitized with potassium bichromate and exposed in the usual way with the film in contact with mercury until a faint brown image appears. H. Ives used silvered celluloid to form the reflective backing instead of mercury in the above. He has also described an exhibition diffraction-color photographic process¹¹ consisting of three superposed or mixed images printed in fine diffraction lines in clear gelatin to represent the three primary colors and their combinations, the spacing of the lines being per inch, 2000 lines for the red, 2600 for the green and 2900 for the blue. A. Berthon¹² employs a diaphragm of strips of dyed gelatin inserted in the lens. J. Frachebourg¹³ and also E. Becquerol¹⁴ have contributed to the development of

Zentr. 1910, **81**, II, 428.

20. D. R. P. 196768; abst. Wag. Jahr 1908, **54**, II, 496, Chem. Ztg Rep. 1908, **32**, 228.

21. E. P. 24234, 1902, abst. J. S. C. I. 1903, **22**, 1148.

1. Brit. J. Phot. 1906, **53**, 469.

2. E. P. 11033, 11346, 1906; abst. Brit. J. Phot. 1907, **54**, 430. E. P. 3385, 1912.

3. E. P. 23826, 1899. J. S. C. I. 1900, **19**, 1108.

4. E. P. 27818, 1900. J. S. C. I. 1911, **30**, 447.

5. E. P. 17979, 1913, abst. C. A. 1915, **9**, 274.

6. Brit. J. Phot. 1897, **44**, 476, 1906, **53**, 588, 1907, **54**, Suppl. 9; 1908, **55**, Suppl. 28. See also H. Vogel, Phot. News, 1894, **38**, 713, in reply to E. Wall, Phot. News, 1894, **38**, 394.

7. E. P. 824, 1894; abst. Phot. News, 1894, **38**, 207.

8. E. P. 5522, 1881.

9. E. P. 5692, 1907.

10. Compt. rend. 1905, **140**, 1508. For further details see Phot. News, 1891, **35**, 137, 140, 197; 1894, **40**, 790; 1897, **43**, 291. E. Fawcett, Phot. News, 1900, **44**, 248, 266, 279. Phot. News, 1908, **53**, 359. See also Brit. J. Phot. 1871, **18**, 363; 1896, **44**, 20, 1900, **47**, 167. For theories on light explanatory of the nature of the colors produced in a Lippmann plate see O. Wiener, Wied. Ann. Phys. 1887, **31**, 629; 1890, **40**, 203, 744. C. Wiener, Wied. Ann. Phys. 1892, **47**, 638, 659.

11. U. S. P. 817569, 1906. See also F. Ives, U. S. P. 839853, 1907; 898369, 1908.

12. Phot. Ind. 1910, 337.

13. E. P. 2318, 1914; abst. C. A. 1915, **9**, 2001.

14. Phot. News, 1874, **18**, 508. See P. Jourdain, Brit. J. Phot. 1900, **47**, 693. In the method of the Natural Color Pictures Co. (E. P. 143180; abst. C. A. 1920, **14**, 2765), the two negatives taken through two filters are printed together in register on opposite sides of a transparent film, both sides being toned to a color corresponding to the color filtered by one of the

this branch of interference photometry within recent years.

In the so-called *bleach out* process, embracing the methods of J. Eder,¹ J. H. Smith,² R. Neuhauss,³ J. Szczepanik,⁴ Farbwerke vorm. Meister, Lucius and Brüning,⁵ W. Merckens⁶ and H. Stobbe,⁷ it has been found that the leucobases of brilliant green, malachite green, crystal violet, rhodamine B, 3B, and 6G, leucaniline and leuco blue are among the dyestuffs sensitive to their respective colors and may be used for actinometric purposes. In collodion they are more light sensitive than the dyes AgBr and AgCl films used in photometry, and also are sensitive to ultraviolet. It has been found in sensibilizing of the bleaching out colors in gelatin or collodion, that many ethereal oils, as pepper-mint oil, are suitable.

Cinematography or the art of Moving Pictures, which at the present time stands second in magnitude as a commercial industry, and whose ramifications are daily becoming more complex and far-reaching, is traceable in embryonic form back to the first days of collodion photography. It is rather difficult to perceive the direct bearing of some of the earlier work in this field upon present-day practice, and the contributory causes of the phenomenal expansion of this cellulose field of usefulness.

Touching upon some of the salient points only, and that briefly in chronological order as best serving our purpose in this taking colors and subsequently the positive from the negative taken through the other filter is modified in color by a second toning bath applied only to this positive.

1. Phot. Korr. 1920, **56**, 140; abst. C. A. 1920, **14**, 1644.
2. J. H. Smith and W. Merckens, U. S. P. 1013458, 1912. E. P. 2461, 1907; abst. Brit. J. Phot. 1907, **54**, 771. E. P. 7217, 1907; abst. J. S. C. I. 1907, **26**, 1109. E. P. 5154, 1910. F. P. 373906, 1907. Belg. P. 179515, 1904; 197512, 1907. D. R. P. Anm. S-22257, 1906. See also J. H. Smith and N. Stafford, D. R. P. 223195, 1908; abst. C. A. 1910, **4**, 3045; Zts. ang. Chem. 1910, **23**, 1958; Chem. Zentr. 1910, **81**, II, 428.
3. Brit. J. Phot. Suppl. 1907, **1**, 14.
4. E. P. 17065, 1908; abst. J. S. C. I. 1908, **27**, 1178. U. S. P. 821200, 1906.
5. E. P. 4994, 1904; abst. J. S. C. I. 1905, **24**, 151. See H. Vogel, Zts. prakt. Phot. 1880, **2**, 54.
6. Brit. J. Phot. 1909, **56**, Suppl. 1.
7. D. R. P. 209993, 1907; abst. C. A. 1909, **3**, 2095; Chem. Zentr. 1909, **89**, I, 1839; Chem. Ztg. Rep. 1909, **33**, 332; Wag. Jahr. 1909, **55**, II, 517; Brit. J. Phot. 1909, **56**, Suppl. 56. See also Zts. ang. Chem. 1908, **21**, 388; Zts. Elektrochem. 1908, **18**, 473, 482. Ann. 1908, **359**, I. For the preparation of the "fulgides" used in this process see Ber. 1904, **37**, 2232, 2240, 2656; 1905, **38**, 3673, 3682, 3893, 3897, 4075, 4081, 4087; 1906, **39**, 292, 761.

historical sketch, and going back to the period 1850-1859, we find the iodized collodion patent of J. Cutting dated July 4, 1854,¹ and the efforts of Mathis,² J. Spiller and W. Crookes,³ Woods,⁴ Schor,⁵ Hlasiwetz,⁶ J. Montizon,⁷ Newton,⁸ G. Shadbolt,⁹ Crawford,¹⁰ Mansell,¹¹ J. Mayall,¹² Gaudin,¹³ Rollason,¹⁴ Auer,¹⁵ J. Schnauss,¹⁶ Geofray,¹⁷ Blot,¹⁸ Llewellyn,¹⁹ Robiquet and Duboscq,²⁰ Corbin,²¹ Festeau,²² and A. Parkes,²³ are the pioneers whose names stand out as being the forerunners and forefathers of this gigantic industry.²⁴ It is, of course, inconceivable that their intuition was so far-reaching and acute as to discern the potentialities of individually relatively unimportant researches, and it has been only by the gradual building up and application of the increment of knowledge of those who have preceded—a combination of chemical manipulation, mathematical physics and an engineering skill of a high order—that the process of passing a succession of photographic

1. U. S. P. 11213, 1854; abst. Rept. Pat. Inv. 1855, **25**, 373, Lond. J. (N. S.) **1**, 296; Poly. Centr. 1855, **21**, 942. E. P. 1638, 1854; Dingl. Poly. 1855, **136**, 206.
2. Poly. Centr. 1854, **20**, 124.
3. Phil. Mag. 1854, **7**, 349; **8**, 111; Dingl. Poly. 1854, **132**, 360, **133**, 287; Mech. Mag. **61**, 149; Poly. Centr. 1854, **20**, 1330. See also Phil. Mag. 1856, **11**, 334; Dingl. Poly. 1856, **140**, 352; Poly. Centr. 1856, **22**, 1073.
4. Phil. Mag. 1854, **8**, 24; Bibl. Univ. Suppl. **26**, 357; Dingl. Poly. 1854, **134**, 126. Phil. Mag. 1855, **9**, 398; Dingl. Poly. 1855, **136**, 378.
5. Dingl. Poly. 1854, **132**, 435.
6. Dingl. Poly. 1854, **133**, 118; Poly. Centr. 1854, **20**, 1269.
7. Dingl. Poly. 1854, **133**, 357; Poly. Centr. 1854, **20**, 1263.
8. Poly. Centr. 1854, **20**, 1266, 1267.
9. Dingl. Poly. 1854, **133**, 433; 1855, **136**, 56; Poly. Centr. 1855, **21**, 49, 174.
10. Poly. Centr. 1855, **21**, 175.
11. Poly. Centr. 1855, **21**, 630.
12. Dingl. Poly. 1855, **137**, 268; Poly. Centr. 1855, **21**, 1200.
13. Dingl. Poly. 1855, **137**, 462; Poly. Centr. 1856, **22**, 506.
14. Lond. J. Arts. (N. S.) **3**, 27; Mech. Mag. **64**, 132.
15. Dingl. Poly. 1856, **139**, 194; Poly. Centr. 1856, **22**, 753.
16. Dingl. Poly. 1856, **140**, 45; Poly. Centr. 1856, **22**, 1252.
17. Poly. Centr. 1856, **22**, 754.
18. Poly. Centr. 1856, **22**, 874.
19. Poly. Centr. 1856, **22**, 1148.
20. Compt. rend. 1856, **43**, 1194; Dingl. Poly. 1857, **143**, 189; Poly. Centr. 1857, **23**, 468.
21. F. P. 18016, 1857.
22. Bull. Soc. Franc. Phot. 1855, **1**, 129, 144.
23. E. P. 1123, 1856. See Brit. Phot. 1881, **28**, 578.
24. See Poly. Centr. 1854, **20**, 943, 1086, 1261, 1329, 1449; 1855, **21**, 48, 174, 369, 632, 942, 1197; 1856, **22**, 47, 175, 357; 1857, **23**, 1024, 1512. Rep. encycl. de Phot. de la Blanchère, 1863, **2**, 187. Bull. Soc. Franc. Phot. 1869, **15**, 286.

- images before the eye with such rapidity as to convey the delusion of motion, has reached the present day state of perfection.

In the decade 1860-1869,¹ appeared the "pellicle Marion," or "Marion's transparent tissue,"² an endeavor to provide a light support for dry collodion negatives. C. Silvy in 1867³ reported upon this film, which was a transfer process from collodion on glass to a transparent or translucent paper. G. Ray in 1865⁴ poured collodion on a glass plate and formed a film. Then gelatin was poured on, and finally paper. Although Ray was endeavoring to make a washable collar and cuff, the germ of the photo-film idea was there. L. Schrank⁵ Wothly,⁶ Ryley and Parry,⁷ C. Sellers,⁸ T. Sutton and S. Wortley,⁹ J. Schnauss,¹⁰ M. Gaudin,¹¹ Garneri,¹² Hislop,¹³ Malderen,¹⁴ A. Disderi,¹⁵ Sabatier,¹⁶ G. Simpson,¹⁷ Jane,¹⁸ L. anjarrois,¹⁹ Testelin,²⁰ Reynaud,²¹ Bertrand,²² D. v. Monckhoven,²³ Weiske,²⁴ Reynolds,²⁵ L. Kleffel,²⁶ Vilette,²⁷

1. Probably the first patent for moving pictures was granted to L. Ducos du Hauron on March 1, 1864, F. P. 61976, who employed the term "cinematographie."

2. Brit. J. Phot. 1862, **9**, 308; 1869, **16**, 155. Phot. News, 1868, **12**, 230. Bull. Soc. Franc. Phot. 1870, **16**, 5. Rep. encycl. Phot. de la Blanchère, 1863, **3**, 111. G. Balagny's Traité de Phot. par les Procédés Pelliculaires, 1880, **1**, 14.

3. Bull. Soc. Franc. Phot. 1867, **13**, 37.

4. U. S. P. 48230, 1865.

5. Phot. News, 1868, **12**, 488.

6. Compt. rend. 1860, **51**, 558, Dingl. Poly. 1860, **158**, 237, Poly. Centr. 1861, **27**, 281.

7. Dingl. Poly. 1860, **158**, 318, Poly. Centr. 1861, **27**, 213.

8. Horn's Phot. J. 1861, **16**, 41.

9. Horn's Phot. J. 1861, **16**, 79, 91.

10. Poly. Centr. 1861, **27**, 1654. Dingl. Poly. 1863, **167**, 182, Poly. Centr. 1863, **29**, 448.

11. Horn's Phot. J. 1862, **17**, 3, 30, 34.

12. Horn's Phot. J. 1862, **17**, 52.

13. Horn's Phot. J. 1862, **17**, 75.

14. Horn's Phot. J. 1862, **17**, 93.

15. Horn's Phot. J. 1862, **18**, 5.

16. Horn's Phot. J. 1862, **18**, 20, 50.

17. Horn's Phot. J. 1862, **18**, 28.

18. Horn's Phot. J. 1862, **18**, 36.

19. Horn's Phot. J. 1862, **18**, 45.

20. Horn's Phot. J. 1862, **18**, 54, 62.

21. Horn's Phot. J. 1862, **18**, 64.

22. Horn's Phot. J. 1862, **18**, 66.

23. Wieck's Gerwerbeztg. 1863, 367.

24. Wieck's Gerwerbeztg. 1864, 316.

25. Poly. Centr. 1865, **31**, 336.

26. Wieck's Gerwerbeztg. 1865, 122.

27. Wieck's Gerwerbeztg. 1866, 47.

W. England,¹ J. Obernetter,² and H. Voigt³ have also contributed.

M. Risler⁴ sought to replace glass by mica, as being similarly transparent, less fragile and more manageable. The pellicle of A. Martin⁵ and the collodion positive photographs of E. Pettitt⁶ are worthy of mention.

The ten years 1870-1879 may be said to comprize the real formative period for the advent of cinematographic films as we understand them at present, the number of memoirs and patented processes appearing, while not numerous, yet were important from the viewpoint of advances made in the succeeding decennial period. They included the contributions of Despaquis,⁷ G. Dawson,⁸ J. Ellerbeck,⁹ J. Ferrier,¹⁰ P. Liesegang,¹¹ A. Pumphrey,¹² Schippang & Wehenkel,¹³ H. Vogel,¹⁴ A. Wortley and W. Ver non,¹⁵ Sandtner¹⁶ and others.¹⁷

Especially noteworthy was the "sensitive tissue" of L. Warnerke.¹⁸ Up to this time efforts were being crystallized towards replacing glass by a less fragile, lighter and more easily portable material, and Warnerke had met the requirements of toughness and portability in a measure by placing a collodion strip on glass, still it was a roundabout procedure involving the transfer or removal of the collodion film from its original bed, either before or after exposure. Still it must be admitted that

1. Phot. Mitth. 1867, **4**, 59
2. Phot. Mitth. 1867, **4**, 266
3. Phot. Mitth. 1868, **5**, 28
4. E. P. 2954, 1863, E. P. 60537, 1863
5. Bull. Soc. Franc. Phot. 1868, **14**, 96
6. E. P. 72, 1865.
7. Bull. Soc. Franc. Phot. 1870, **16**, 6
8. Brit. J. Phot. 1870, **17**, 540
9. Phot. News, 1877, **21**, 99
10. E. P. 129980, 1879, abst. Bull. Soc. Franc. Phot. 1879, 125, Mon. Sci. 1880, **22**, 954. E. P. 1559, 1881. Brit. J. Phot. 1880, **27**, 453.
11. Phot. News, 1877, **21**, 435
12. E. P. 1559, 1881, abst. Brit. J. Phot. 1882, **29**, 9, Bull. Soc. Franc. Phot. 1879, 125.
13. D. R. P. 9890, 1879, abst. Chem. Centr. 1880, **51**, 560; Wag. Jahr. 1880, **26**, 797.
14. Ber. 1871, **4**, 827, Phot. Mitth. 1894, **30**, 113
15. E. P. 2347, 1864. See also Brit. J. Phot. 1870, **17**, 335, 1871, **18**, 429, 572.
16. D. R. P. 5988, 1879
17. See Brit. J. Phot. 1874, **21**, 132, 288, 1877, **24**, 505, Phot. News, 1875, **19**, 294; 1879, **23**, 43.
18. Phot. News, 1875, **19**, 303, 559, Bull. Soc. Franc. Phot. 1875, **21**, 201. Brit. J. Phot. 1896, **33**, 213, 1905, **32**, 484.

*this was a distinct and noteworthy advancement in the art.

The ten-year period 1880-1889 may be truly said to be epoch-making in its importance. It was becoming pretty well recognized that collodion and hence photography had its limitations—which limitations were fast being approached—unless some method was devised or process evolved whereby the cumbersome glass sheets could be superseded by a non-frangible and supple material. Among the advances contributory in a noteworthy manner, may be mentioned the publications of Alexandre,¹ J. Bonnaud,² J. Brown,³ J. Carbutt,⁴ de Chennevieres,⁵ F. Crane,⁶ A. Chardon,⁷ M. David,⁸ E. Ellis,⁹ G. Eastman,¹⁰ G. Eastman and W. Walker,¹¹ F. Froedman,¹² E. Foxlee,¹³ J. Journaud,¹⁴ P. Mortier,¹⁵ H. Manfield,¹⁶ A. Nowicki,¹⁷ E. Perry,¹⁸ H. Palmer,¹⁹ A. Thiebaut,²⁰ J. Thornton,²¹ Fortier and David,²² B. Wollaston,²³ and J. Williams.²⁴ J. Waterhouse²⁵ described his amyl acetate-collodion photo-

1. F. P. 142557, 1881; abst. Mon. Sci. 1882, **24**, 732.
2. E. P. 4537, 1888; abst. Brit. J. Phot. 1889, **36**, 166.
3. E. P. 12521, 1887.
4. Phot. News, 1888, **32**, 737, 806; Brit. J. Phot. 1888, **35**, 807; Eder's Jahr. Phot. 1890, **4**, 249. Phot. Mitth. 1889, **25**, 8, 250, 305.
5. Bull. Soc. Franc. Phot. 1885, 150; C. Fabre's Traité encycl. Phot. 1890, **2**, 351.
6. E. P. 6542, 1893; abst. Brit. J. Phot. 1893, **40**, 205. E. P. 10393, 1889.
7. Bull. Soc. Franc. Phot. 1881, **27**, 210.
8. Phot. News, 1881, **25**, 187; 1882, **26**, 139; 1890, **34**, 303.
9. U. S. P. 385797, 1888; abst. Phot. News, 1888, **32**, 494.
10. U. S. P. 306594, 441831, 584862; E. P. 19896, 19897, 1889; abst. Phot. News, 1889, **33**, 864. E. P. 19658, 1890; 7501, 1892.
11. U. S. P. 306470, 1884; 420130, 1890.
12. U. S. P. 386006, 1888. E. P. 10659, 1886.
13. E. P. 15727, 1886; abst. Phot. News, 1887, **31**, 638. E. P. 3393, 1890; abst. Brit. J. Phot. 1891, **38**, 154.
14. Belg. P. 72894, 1886.
15. E. P. 22713, 1898.
16. Phot. News, 1887, **31**, 148; Brit. J. Phot. 1887, **34**, 153.
17. Phot. News, 1888, **32**, 19.
18. E. P. 405, 1888; abst. Phot. News, 1888, **32**, 809.
19. Phot. News, 1881, **25**, 165. E. P. 16313, 1900.
20. E. P. 1608, 1883. See Phot. News, 1884, **28**, 135; G. Balagny's Traité de Phot. par les Procédés Pelliculaires, 1889, **1**, 32.
21. E. P. 16018, 1887; abst. Brit. J. Phot. 1887, **34**, 764; 1888, **35**, 700. E. P. 5793, 1899; abst. J. S. C. I. 1900, **19**, 274, 559. E. P. 14094, 1899; 11033, 21189, 1906; 3385, 4044, 29112, 29513, 1912; abst. C. A. 1914, **8**, 1924. J. Thornton and C. Rothwell, U. S. P. 760585, 1904; E. P. 887, 4237, 17165, 17446, 1899; abst. J. S. C. I. 1900, **19**, 157, 274, 689; 1901, **20**, 68; 1904, **23**, 680.
22. Brit. J. Phot. 1881, **28**, 352.
23. Brit. J. Phot. 1887, **34**, 442.
24. E. P. 12309, 1889; abst. Brit. J. Phot. 1891, **38**, 174.
25. Phot. News, 1889, **33**, 275. Year Book Phot. 1890, 126.

graphic film, while the Warnerke film¹ was commercially established. Many minor contributions were made.² In France, the collodion film of G. Balagny³ had attained considerable prominence. Of far-reaching significance,⁴ however, was the U. S. Patent Application of May 2, 1887, of the Rev. Hannibal Goodwin, of Newark, N. J., which was held up until September 13, 1898, when it then issued as U. S. Patent 610861. Goodwin clearly sets forth the object of his invention as intending to primarily provide a sensitive, transparent, water resistant pellicle better adapted for photographic purposes, especially in connection with roller cameras, his claims admitting of the film being made "in lengths of indefinite extension." On April 9, 1889, H. Reichenbach applied in the U. S. Patent Office for protection for a film in many respects similar to that of Goodwin and the Reichenbach patent was granted as U. S. P. 417202, 1889.⁵ Although Goodwin's patent was applied for two years before that of Reichenbach, it slumbered in the Patent Office archives for over nine years before issuance, i. e., the Reichenbach process was known to the world for nine years before the prior Goodwin patent was granted. Litigation immediately ensued between the Eastman Kodak Co. as owners of the patent of Reichenbach, and the Ansco Co., to whom had been assigned the Goodwin claims. The patent was adjudicated in 1913 in favor of the latter.⁶

1. Brit. J. Phot. 1885, **32**, 560; 1897, **44**, 302, 206.

2. G. Mansfield, Brit. J. Phot. 1888, **35**, 831. E. Stebbing, Brit. J. Phot. 1881, **28**, 244. Muybridge, Brit. J. Phot. 1883, **27**, 242. J. Forrest, Brit. J. Phot. 1889, **36**, 659. J. Eder, Brit. J. Phot. 1883, **30**, 391. W. England, Brit. J. Phot. 1892, **39**, 87; 1889, **36**, 833. See also Brit. J. Phot. 1880, **27**, 414; 1882, **29**, 55; 1885, **32**, 46, 155, 253, 417, 433, 465, 561, 639; 1887, **34**, 150; 1889, **33**, 192, 469, 619. Phot. Mitth. 1889, **25**, 233.

3. Bull. Soc. Franc. Phot. 1885, (2), **1**, 41; 1892, **8**, 177; 1893, **9**, 625. *Traité encycl. de Phot.* 352. *Traité de Phot. par les Procédés Pelliculaires*, 1889, **1**, 33. Phot. News, 1880, **24**, 591.

4. Other patents on photographic surfaces, granted to H. Goodwin, are U. S. P. 444951, 444952, 450136, 450137, 1892; 509124, 1893; 600688, 610398, 1898; 670277, 1901; 700140, 1902; 517275, 1894; 570728, 574147, 1896. Being a resident of Newark, presumably Goodwin soon heard of the value of amyl acetate as a solvent. Important connecting point. The discovery of amyl acetate rendered possible the manufacture of an acceptable continuous photographic support and Goodwin patented a photo support which utilized the valuable properties of amyl acetate.

5. See also U. S. P. 479305, 1892; abst. J. A. C. S. 1892, **14**, 292. H. Reichenbach and S. Passavant, U. S. P. 458663, 1891.

6. The United States District Court, on Aug. 8, 1913, represented by Judge J. Hazel said: "It follows that the complainant is entitled to a decree with costs for an injunction and accounting as to claims 1, 6, 8, 10 and 12 covering the process and product of the patent in suit, which in my estima-

From 1890 to 1899 interest in this subject was intense, as shown by the multiplicity of contributions in this field. The crystallos¹ and flexoid² were placed on the market—of a nitro-cellulose base, and advances in *pellicular negatives*, was substantial and far-reaching during this half score years. Among those who contributed, may be mentioned J. Acworth,³ E. and H. Anthony & Co.,⁴ F. Axtell,⁵ E. Asselot,⁶ H. Burn,⁷ W. Bolton,⁸ T. Blair and The European Blair Camera Co.,⁹ W. Barnes,¹⁰ L. Bethisy,¹¹ tion are infringed by the defendant company. So ordered." The decree of Judge Hazel was confirmed by the United States Circuit Court of Appeals, who said: "It is said that a motion is pending in the District Court for an order extending the time during which the complainant may recover profits and damages to the date of the Goodwin patent. This motion was postponed by stipulation until after the decision of this Court, and we are asked to make this affirmation 'subject to the motion and stipulation referred to.' We do not see that any action by this court is necessary as the District Court will have full jurisdiction in the premises. The other assignments of error are sufficiently discussed in Judge Hazel's opinion and we see no necessity for adding to what is there so clearly stated. The decree is affirmed." Points of moment in the Goodwin patent are as follows: "An improvement in the art of making transparent flexible, photographic-film pellicles, the same consisting in dissolving nitrocellulose in a menstruum containing a hygroscopic element and an element which is non-hygroscopic, the non-hygroscopic element being of itself a solvent of nitrocellulose, and of slower volatility than the hygroscopic element, depositing and spreading such solution upon a supporting surface, and allowing it to set and dry and harden by evaporation, and spreading a photographically-sensitive solution on the hardened film, and drying the film, substantially as set forth." A claim for "a new article of manufacture." "As a new article of manufacture, a transparent film support for photographic purposes, the same consisting of a thin, non-greasy, film, foil, or pellicle of a dried and hardened celluloidal solution of nitrocellulose, combining in addition to the following essential properties of glass-plate supports, *viz*, insolubility in developing fluids, insensibility to heat and moisture, imporosity of structure, and hardness, smoothness, and brilliancy of surface, the further desirable properties of exceeding thinness, lightness in weight, toughness in texture and elasticity in flexure, as and for the purpose specified." Claim 12 is: "The process of manufacturing photographically sensitive pellicles, consisting of flowing a non-photographically sensitive solution of nitrocellulose dissolved in a non-hygroscopic liquid, or a liquid which is eventually non-hygroscopic, and drying and hardening such compound into a support for photographically-sensitive emulsion and imposing on such support the said sensitive emulsion, substantially as set forth." The main claims of the patent are 1, 6, 8, 10, 12, covering the process and product.

1. Brit. J. Phot. 1891, **38**, 57.
2. Brit. J. Phot. 1899, **46**, 274.
3. E. P. 13836, 1890; abstr. Brit. J. Phot. 1891, **38**, 509.
4. U. S. P. 591346, 1897.
5. U. S. P. 623063, 1899.
6. Brit. J. Phot. 1897, **44**, 58.
7. Brit. J. Phot. 1890, **37**, 159.
8. Brit. J. Phot. 1893, **40**, 796.
9. Brit. J. Phot. 1895, **42**, 186.
10. Brit. J. Phot. 1893, **40**, 623.
11. Brit. J. Phot. 1899, **46**, 4.

P. Cady,¹ J. Chorley,² F. Crane and J. Wellington,³ H. Conybeare,⁴ Dieskau,⁵ B. Edwards,⁶ F. Edwards and H. Ransom,⁷ Eastman Phot. Mat. Co.,⁸ E. Fitch & Co.,⁹ J. Fairfax,¹⁰ W. Friese-Greene,¹¹ O. Hymmen,¹² S. Highley,¹³ J. Hopwood,¹⁴ A. Haddon,¹⁵ H. Klepp,¹⁶ W. Kidston,¹⁷ C. King and R. Jellicoe,¹⁸ H. Krause and H. Schneider,¹⁹ W. Latham,²⁰ Lumière et ses fils,²¹ O. Moh,²² O. Moh, A. Heseckiel and J. Grunewald,²³ G. Macaire,²⁴ A. McCurdy,²⁵ Farbwerke vorm. Meister, Lucius and Bruning,²⁶ C. Mostyn,²⁷ A. Newman and Newman & Guardia, Ltd.,²⁸ W. Quin,²⁹ R. Penniman,³⁰ Perutz,³¹ M. Portman,³² J. Pike,³³ J. Parsons,³⁴

1. See Eder's Jahr. Phot. 1903, **17**, 475.
2. Swiss P. 18998, 1899.
3. E. P. 11821, 14274, 1895.
4. Brit. J. Phot. 1894, **41**, 432.
5. Phot. Mitth. 1894, **30**, 75.
6. E. P. 8650, 1893; abst. Brit. J. Phot. 1893, **40**, 265.
7. E. P. 12304, 1893; abst. Brit. J. Phot. 1893, **40**, 567.
8. D. R. P. 69231, 1892.
9. Brit. J. Phot. 1895, **42**, 778; 1896, **43**, 252; Photography, 1890, **2**, 28.
10. Phot. News, 1890, **34**, 569.
11. E. P. 29363, 1897.
12. Brit. J. Phot. 1899, **46**, 266.
13. Brit. J. Phot. 1891, **38**, 89, 104.
14. Brit. J. Phot. 1892, **39**, 533.
15. Phot. News, 1890, **34**, 288.
16. Phot. Mitth. 1895, **31**, 299.
17. Brit. J. Phot. 1897, **44**, 746.
18. E. P. 15686, 24605, 1893.
19. U. S. P. 497884, 1893.
20. E. P. 12785, 1897.
21. E. P. 7132, 1907; abst. J. S. C. I. 1907, **26**, 1255. E. P. 16114, 16115, 1908; abst. Brit. J. Phot. 1909, **56**, 329; Phot. Mitth. 1909, **28**, J. S. C. I. 1909, **28**, 491; Chem. Ztg. Rep. 1909, **33**, 484. E. P. 375433, 400739. V. Planchon, U. S. P. 1116479; abst. J. S. C. I. 1914, **33**, 1227. See also Brit. J. Phot. 1907, **54**, 92; 1908, **55**, 953. Précis de Phot. gen. 1905, **2**, 141.
22. U. S. P. 645209, 1900; 953175; abst. C. A. 1910, **4**, 1432. D. R. P. 117310, 1898; 204868, 1906; abst. C. A. 1909, **3**, 1730; J. S. C. I. 1909, **28**, 110. See Brit. J. Phot. 1897, **44**, 168.
23. E. P. 24750, 1898. Brit. J. Phot. 1899, **46**, 134.
24. E. P. 12152, 1899; abst. Brit. J. Phot. 1900, **47**, 314. U. S. P. 861472, 1907.
25. D. R. P. 129484, 1899. Brit. J. Phot. 1900, **47**, 104. U. S. P. 1261747, 1261748, 1918. E. P. 122391, 1918; abst. C. A. 1919, **13**, 1679. Can. P. 186045.
26. E. P. 25434, 1899; abst. Brit. J. Phot. 1901, **48**, 11.
27. Brit. J. Phot. 1895, **42**, 459.
28. E. P. 18643, 1898.
29. Brit. J. Phot. 1897, **44**, 807.
30. U. S. P. 550288, 1895.
31. Phot. Mitth. 1895, **32**, SB 327; 1898-1899, **35**, 137.
32. Brit. J. Phot. 1895, **42**, 797.
33. Brit. J. Phot. 1895, **42**, 726.
34. E. P. 13926, 1893; abst. Brit. J. Phot. 1893, **40**, 97.

J. Swan,¹ M. Lefferts and J. Stevens,² A. Sexton,³ Chem. Fabrik. vorm. E. Schering,⁴ Schleussner,⁵ W. Stillman,⁶ J. Thornton and C. Rothwell,⁷ A. Watkins,⁸ W. Washam,⁹ E. Vogel,¹⁰ W. Walker,¹¹ J. Wellington,¹² and others.¹³ It was during this period that the setoloid films of A. Edwards¹⁴ were placed on the market.

In the five-year period 1900-1904, advances were comparatively few and, in general, not of far-reaching importance, as is indicated by the publications of Actien-Gesellschaft für Anilin Fabrikation,¹⁵ R. Anthony,¹⁶ L. Armandy,¹⁷ M. Bry,¹⁸ T. Brown,¹⁹ F. Bayer & Co.,²⁰ J. Findlay,²¹ J. Hodges,²² T. Haddow,²³ Kodak, G. m. b. H.,²⁴ Sandell Films and Plates, Ltd., and W. Smalley,²⁵

1. E. P. 9893, 1890; abst. Brit. J. Phot. 1891, **38**, 411.
2. U. S. P. 573928, 1896; 600824, 1898.
3. Phot. News, 1898, **42**, 42.
4. E. P. 2036, 1894. D. R. P. 100890, 1897.
5. Phot. Mitth. 1891-1892, **28**, 366; 1894, **30**, SB 75.
6. Brit. J. Phot. 1895, **42**, 15.
7. U. S. P. 760585, 786534, 786535; abst. J. S. C. I. 1904, **23**, 680; 1905, **24**, 513. E. P. 17165, 17292, 17446, 1899; abst. J. S. C. I. 1900, **19**, 68, 689.
8. Brit. J. Phot. 1893, **40**, 823.
9. Brit. J. Phot. 1894, **41**, 335.
10. Ber. 1891, **24**, 134. Phot. Mitth. 1898-1899, **35**, 125.
11. Brit. J. Phot. 1890, **37**, 91.
12. E. P. 11821, 1895; abst. Brit. J. Phot. 1896, **43**, 381. See also E. P. 11253, 1892; 14272, 1893.
13. Photography, 1890, **2**, 123, 350; 1891, **3**, 4, 59, 689; 1892, **4**, 282, 398, 414, 415; 1893, **5**, 14, 148, 791; 1894, **6**, 292; 1895, **7**, 732; 1896, **8**, 32, 47; 1898, **10**, 389, 437, 727; 1899, **11**, 730. Phot. Annual. 1891, 76, 80; 1892, 82; 1895, 164. Amat. Phot. 1891, **14**, Q-266, A-286. Précis de Phot. gen. 1905, **2**, 142. Phot. News, 1890, **34**, 231, 591; 1892, **36**, 86. Brit. J. Phot. 1890, **37**, 164, 401, 476; 1891, **38**, 191, 739; 1892, **39**, 81, 305; 1893, **40**, 193, 306, 555, 711, 761, 807; 1895, **42**, 67; 1897, **44**, 61, 177, 270, 483, 677; 1899, **46**, 84, 422. Phot. Mitth. 1890-1891, **27**, 62, 88; 1891-1892, **28**, 208, 366; 1893, **29**, 76; 1894, **30**, 302; 1895, **31**, 74; **32**, 95, 245; 1897-1898, **34**, 30; 1898-1899, **35**, 116, 137, 235, 267. Phot. Mag. **29**, 133; Sci. Amer. Suppl. **33**, 13530. J. of Phot. 1898, **45**, 692. Gewerbebl. Bayern, **23**, 119.
14. Phot. News, 1897, **41**, 254.
15. E. P. 2770, 1900; 9062, 1904. D. R. P. 132693, 133063, 137962, 1901; 161213; abst. Brit. J. Phot. 1905, **52**, 587.
16. U. S. P. 735436, 1903; abst. J. A. C. S. 1904, **26R**, 134; Mon. Sci. 1904, **61**, 39.
17. U. S. P. 717793, 1903; abst. J. S. C. I. 1903, **22**, 164.
18. E. P. 24774, 1904; abst. J. S. C. I. 1905, **24**, 249. F. P. 345535, 1904.
19. E. P. 10277, 12997, 1903.
20. E. P. 17009, 1909; abst. Brit. J. Phot. 1910, **57**, 536. F. P. 317008, 1901; 320694, 1902; abst. J. S. C. I. 1903, **22**, 165.
21. U. S. P. 822107, 1906. E. P. 5948, 1904; abst. J. S. C. I. 1905, **24**, 512.
22. Brit. J. Phot. 1904, **51**, 478.
23. Brit. J. Phot. 1902, **49**, 407.
24. D. R. P. 147948, 1903.
25. E. P. 25243, 1902; abst. J. S. C. I. 1903, **22**, 1148. See W. Smalley, U. S. P. 723054, 1903; abst. J. S. C. I. 1903, **22**, 511.

H. Lüttke,¹ S. Lubin,² A. Miethe and H. Fritzsche,³ J. Meek,⁴ J. Oliver,⁵ A. Plaissetty,⁶ Societe Anonyme de Pellicules Francaise,⁷ H. Spörl,⁸ C. Stearn,⁹ R. Talbot,¹⁰ Société Volfz, Weiss & Co.,¹¹ G. Woodward,¹² and others.¹³

However in the next five years (1905-1910) there appeared a marked recrudescence in interest and advancement in collodion films, especially along lines of continuous film formation, and many disclosures of meritorious character are to be recorded. From these may be cited the contributions to cinematographic films of Bremer Trockenplatten Fabrik B. Klatte,¹⁴ B. Borzykowski,¹⁵ J. Bordeaux,¹⁶ T. Barrasford and W. Faulkner,¹⁷ C. Bensinger and M. Euller,¹⁸ J. Bianchi,¹⁹ J. Brandenberger,²⁰ C. Chandon de Briailles,²¹ Cie generale de phonographes, cinemato-

1. E. P. 24955, 1902. Belg. P. 166300, 1902.
2. U. S. P. 657555, 1900.
3. D. R. P. 155778, 1903.
4. E. P. 4018, 1904; abst. Brit. J. Phot. 1904, **51**, 192.
5. Brit. J. Phot. 1903, **50**, 408, 428.
6. E. P. 9087, 1900; abst. J. S. C. I. 1900, **19**, 584; Chem. Ztg. 1901, **25**, 803.
7. D. R. P. 133250, 1901.
8. D. R. P. 124849, 1900.
9. E. P. 2529, 1902; abst. J. S. C. I. 1903, **22**, 569.
10. D. R. P. 155179, 1903; 161712, 1904.
11. F. P. 321397, 1902; abst. J. S. C. I. 1903, **22**, 319.
12. E. P. 9277, 1904; abst. J. S. C. I. 1905, **24**, 149; Chem. Ztg. 1905, **29**, 886.
13. J. Baldock, Brit. J. Phot. 1904, **51**, 323. Chemische Fabrik vorm. Weiler ter Meer, E. P. 15435, 1904; abst. Brit. J. Phot. 1905, **52**, 473. Compare D. R. P. 124849, 1900. Brit. J. Phot. 1900, **47**, 254; 1902, **49**, 963; 1904, **51**, 963; 1905, **52**, 366. Brit. J. Suppl. 1900, **47**, 51. Photography, 1902, **14**, 497, 628, 860; 1903, **16**, 333; Phot. News, 1904, **48**, 429.
14. F. P. 390572, 1908; E. P. 11341, 1908; abst. J. S. C. I. 1908, **27**, 1223.
15. E. P. 5413, 1907.
16. F. P. 401912, 1909.
17. E. P. 13663, 1903; abst. Brit. J. Phot. 1908, **55**, 534.
18. U. S. P. 863141, 1907.
19. U. S. P. 886673, 1908.
20. U. S. P. 981308; 984886; abst. J. S. C. I. 1911, **30**, 385. U. S. P. 1221825; abst. J. S. C. I. 1917, **36**, 570. E. P. 21007, 24809, 1908; abst. J. S. C. I. 1909, **28**, 851. E. P. 24811, 1908; 13328, 1909; abst. J. S. C. I. 1909, **28**, 1223. E. P. 15190, 1909; abst. J. S. C. I. 1910, **29**, 147; Brit. J. Phot. 1910, **57**, 48. E. P. 15281, 1909. E. P. 20119, 1911. E. P. 4065, 1912; abst. J. S. C. I. 1912, **31**, 98; Kunst. 1913, **3**, 332; C. A. 1913, **7**, 2850; Brit. J. Phot. 1912, **59**, 294. E. P. 27322, 1912. E. P. 13072, 1914; abst. C. A. 1915, **9**, 3037. E. P. 2411, 1915; abst. J. S. C. I. 1915, **34**, 983. F. P. 405429; 413900; abst. J. S. C. I. 1910, **29**, 1135. F. P. 414518, 438476. F. P. 458638; abst. J. S. C. I. 1913, **32**, 1063; Kunst. 1914, **4**, 137. Aust. P. Ann. 4757, 5340, 1909. Aust. P. 61692, 1913. See also O. Dodge, F. P. 379497.
21. E. P. 8542, 1908. F. P. 386845; abst. J. S. C. I. 1909, **27**, 834. F. P. 420044. Australian P. 11440. Can. P. 117759, 1909.

graphes, et appareils de precision,¹ H. Cathelineau and A. Fleury,² W. Caldwell,³ H. Danzer,⁴ C. Dupuis,⁵ E. Donisthorpe,⁶ R. Dockree,⁷ L. Gaumont,⁸ J. Galay,⁹ T. Heizberg,¹⁰ G. Hùe,¹¹ L. Labbe and H. Perret,¹² L. Labbe and V. Pauthonier,¹³ S. Mode Naie,¹⁴ F. De Mare,¹⁵ A. Mailet,¹⁶ I. Oestreicher,¹⁷ A. Patat & Co.,¹⁸ C. Rossi,¹⁹ J. Rey,²⁰ Soc. Civ. des Pellicules Nouvelles pour Cinematographes et autres usages,²¹ Soc. Gen. des Films and C. Gonon,²² Soc. anon. de Cellulose-coton pour Poudres blanches de Guerre et Celluloid,²³ G. and T. Stevens,²⁴ J. Smith,²⁵ L. Smith,²⁶ F. Thomp-

1. E. P. 14039, 1909, abst. J. S. C. I. 1910, **29**, 373; Brit. J. Phot. 1910, **57**, 163. E. P. 14824, 1909, abst. Brit. J. Phot. 1910, **57**, 250. E. P. 14950, 1909. E. P. 21069, 1909, abst. Brit. J. Phot. 1910, **57**, 384. E. P. 27785, 1910; abst. Brit. J. Phot. 1910, **57**, 957. E. P. 2500, 1911. E. P. 6289, 1912; abst. Brit. J. Phot. 1912, **59**, 586; E. P. 19854, 1912; abst. Brit. J. Phot. 1912, **59**, 942. F. P. 410986, 414050, 416554, 423840. D. R. P. 244042; abst. Zts. ang. Chem. 1912, **25**, 789. Can. P. 128799, 1910. Swiss P. 47963, 61929, 1912.
2. E. P. 12277, 1905; abst. J. S. C. I. 1906, **25**, 327. See also E. P. 12278, 1905; F. P. 354942, 1905; abst. J. S. C. I. 1905, **24**, 1169, 1226.
3. E. P. 1689, 1908, abst. Brit. J. Phot. 1908, **55**, 103.
4. U. S. P. 988961, 1911; 1065115; abst. Mon. Sci. 1914, **81**, 39. E. P. 14408, 1909; abst. J. S. C. I. 1909, **28**, 1327. E. P. 3603, 1910, abst. J. S. C. I. 1910, **29**, 978; Brit. J. Phot. 1910, **57**, 536. E. P. 13239, 1912, abst. Brit. J. Phot. 1912, **59**, 586. Addition of March 18, 1910 to F. P. 410725. F. P. 420197. D. R. P. Ann. D-23535. D. R. P. 240046; abst. C. A. 1912, **6**, 2169, Wag. Jahr. 1911, **57**, II, 506; Kunst. 1911, **1**, 456. Belg. P. 218192, 1909. Swiss P. 50235, 1910.
5. E. P. 25165, 1907; 19028, 1909; abst. Brit. J. Phot. 1910, **57**, 712.
6. E. P. 5641, 1908; abst. J. S. C. I. 1909, **28**, 491.
7. E. P. 15841, 1909.
8. F. P. 391897, 1907. U. S. P. 1177697, 1916.
9. E. P. 1715, 1909.
10. Belg. P. 195314, 1906.
11. F. P. 387791, 1907; abst. J. S. C. I. 1908, **27**, 877.
12. F. P. 393627, 1908.
13. F. P. 381637 and add. 8401 thereto, abst. J. S. C. I. 1908, **27**, 184, 420. F. P. 393627, 393628.
14. Belg. P. 194718, 1906.
15. E. P. 7806, 1908. Can. P. 117958. Belg. P. 197920, 198520, 199471, 208141.
16. E. P. 15902, 1907.
17. F. P. 405307, 1909.
18. F. P. 361954, 1905.
19. E. P. 21467, 1909, abst. Brit. J. Phot. 1910, **57**, 250. E. P. 8866, 1912, abst. Brit. J. Phot. 1912, **59**, 1001.
20. F. P. 384206, 1907. Belg. P. 206691, 1908. See also M. Ratignier and H. Pervilhac et Cie. F. P. 395665, 1908.
21. F. P. 384111, 384112, and additions 8470, 8471, 8474, 9465 thereto; abst. J. S. C. I. 1908, **27**, 471.
22. F. P. 388755, 1908.
23. F. P. 379421, 1907; abst. J. S. C. I. 1907, **26**, 1255.
24. E. P. 25188, 1906.
25. U. S. P. 886883; abst. J. S. C. I. 1908, **27**, 592. U. S. P. 923589;

son¹ are among those who have recently contributed.²

- From 1910-1914 may be chronicled the disclosures of E. Buttenshaw,³ G. Bonwitt,⁴ T. Bolam, S. Barnard, and A. Newman,⁵ T. Bolas,⁶ du Boistesselin and Hermand,⁷ Itala Film,⁸ J. Blondel and A. Chopin,⁹ G. Bingham,¹⁰ J. Campbell,¹¹ P. Cattaert,¹² J. Copelevitz-Josephson,¹³ L. Clement and C. Riviere,¹⁴ F. Clement Botrelle,¹⁵ T. Dropiowski,¹⁶ G. Diesser,¹⁷ C. Duren,¹⁸ L. Enjolras,¹⁹ S. Fry,²⁰ F. Fritz,²¹ L. Giess,²² L. Gevaert & Co.,²³ V. Horsman,²⁴ H. Jerne,²⁵ F. Kent,²⁶ L. Lilienfeld,²⁷ E. Lacombe-Lane and W. abst J S C. I. 1909, **28**, 746. E. P. 10372, 1905, abst Brit J Phot 1905, **42**, 794; J. S. C. I. 1905, **24**, 1083. E. P. 1454, 1907, abst J S C. I. 1907, **26**, 779. Belg. P. 184562, 1908. Swiss P. 33594. F. P. 273006, 1907. D. R. P. 168397; abst. Jahr. Chem. 1905-1908, II, 981; Wag. Jahr. 1906, **52**, II, 484.
26. E. P. 16999, 1905, abst J. S. C. I. 1906, **25**, 654. F. P. 369043, 1906. D. R. P. 196763; abst. Wag. Jahr. 1908, **54**, II, 496, Chem. Ztg. Rep. 1908, **32**, 228.
1. E. P. 20965, 1909, abst. Brit. J. Phot. 1910, **57**, 802. E. P. 24555, 1909; abst. Brit. J. Phot. 1910, **57**, 440. F. P. 408554, 1909, abst. J. S. C. I. 1910, **29**, 593. U. S. P. 987092, 1911.
2. A. Behal, E. P. 11512, 1905; abst. Brit. J. Phot. 1905, **52**, 473. R. Ortmann, E. P. 5280, 1904, abst. Brit. J. Phot. 1905, **52**, 253. See also Brit J. Phot. 1905, **52**, 388; 1907, **54**, 231, 495, 1908, **55**, 298, 863, 1909, **56**, 329. D. R. P. 167613; abst. Wag. Jahr. 1906, **52**, II, 487. Wag. Jahr. 1909, **55**, II, 516.
3. E. P. 21834, 1911; abst. Brit. J. Phot. 1912, **59**, 695.
4. Phot. Ind. 1913, 388, 424, 457, Celluloid Ind. 1913, 155, 165, 171, Kunst. 1913, **3**, 239, 291.
5. E. P. 2794, 1914.
6. U. S. P. 964483, 1910, abst. C. A. 1910, **4**, 2774.
7. Belg. P. 242574, 1912.
8. E. P. 23825, 1911; abst. Brit. J. Phot. 1912, **59**, 141.
9. F. P. 455075, 1913.
10. U. S. P. 1045502, 1912.
11. E. P. 7477, 1912.
12. F. P. 441146, 1911; abst. Chem. Ztg. 1912, **36**, 690, Kunst. 1912, **2**, 460.
13. E. P. 5087, 1912; abst. Brit. J. Phot. 1912, **59**, 659.
14. Caout. et Gutta-p. 1911, **8**, 5807.
15. F. P. 421677, 1909; abst. Kunst. 1911, **1**, 174.
16. E. P. 22425, 1910; abst. Brit. J. Phot. 1911, **58**, 87.
17. E. P. 16615, 1912; abst. J. S. C. I. 1913, **32**, 835.
18. F. P. 448869, 1912; abst. J. S. C. I. 1913, **32**, 451.
19. E. P. 7201, 1911; abst. Brit. J. Phot. 1911, **58**, 267.
20. E. P. 12818, 1902; abst. J. S. C. I. 1903, **22**, 709.
21. D. R. P. 218324, 227130; abst. Wag. Jahr. 1910, **56**, II, 533.
22. F. P. 424511, 1911.
23. F. P. 459870, 1913.
24. E. P. 16480, 1910; abst. Brit. J. Phot. 1911, **58**, 460.
25. E. P. 22234, 1913; abst. J. S. C. I. 1914, **33**, 1116.
26. E. P. 29616, 1912; abst. J. S. C. I. 1914, **33**, 221. Cf. E. P. 2162, 1880.
27. F. P. 428448, 1911; abst. J. S. C. I. 1912, **31**, 584.

Pettie,¹ S. von Medveczky,² W. Merckens and H. Manissadjian,³ P. Pierson,⁴ A. Pellerin,⁵ A. Parodi,⁶ G. Plüss,⁷ Société anonyme Française de Chimie Industrielle,⁸ P. Stow,⁹ Selig Polyscope Co.,¹⁰ R. Schröder,¹¹ L. Sarason,¹² A. Seaborne,¹³ J. Thornton and H. Kuhn,¹⁴ M. Vandal,¹⁵ A. Waggett,¹⁶ F. Wentzel,¹⁷ Zentrale f. Wissenschaftliche und Schulkinematographie,¹⁸ and A. Victor,¹⁹ as indicative of the trend of advancement.

From 1915 to 1920 the direction of advancement has not had the perspective of sufficiently elapsed time to enable accurate comparisons of merit to be made. As indicative of the general trend of improvement there may be cited the publications of A. Brixey,²⁰ A. Brewster,²¹ A. Boularan,²² J. Christensen,²³ D. Comstock,²⁴ Canadian Kodak Co., Ltd.,²⁵ Deutsche Celluloid Fabrik,²⁶ H. Degens,²⁷ Edwards,²⁸ Gilpin,²⁹ Hess-Ives Corp.,³⁰ F. Hochstet-

1. E. P. 6886, 1913.
2. E. P. 27283, 1910.
3. E. P. 8646, 8647, 1910; abst. Brit. J. Phot. 1911, **58**, 311, 367; Hung. P. Appl. M-3799.
4. E. P. 26787, 26788, 1913; 9968, 9969, 1914; abst. C. A. 1915, **9**, 1282, 2801; Can. P. 185893, 1918.
5. E. P. 7562, 1913; F. P. 442022; abst. J. S. C. I. 1912, **31**, 916; 1913 **32**, 1006.
6. E. P. 10909, 1913.
7. Ital. P. 133394, 1913.
8. F. P. 425204, 1910.
9. E. P. 20015, 1911; abst. Brit. J. Phot. 1912, **59**, 789.
10. E. P. 2494, 1910; abst. J. S. C. I. 1910, **29**, 1178.
11. E. P. 2326, 1914.
12. Belg. P. 249325, 1912.
13. U. S. P. 1022510, 1912.
14. U. S. P. 1116762, 1914.
15. E. P. 12788, 1912.
16. E. P. 23221, 1911; abst. Brit. J. Phot. 1912, **59**, 335.
17. Kunst. 1911, **1**, 101, 128.
18. D. R. P. 280622, 1914; abst. C. A. 1915, **9**, 2356. E. P. 15181, 1914.
19. U. S. P. 1019931, 1912.
20. U. S. P. 1256288, 1918.
21. E. P. Appl. 18020, 1910; abst. J. S. C. I. 1919, **38**, 560-A.
22. E. P. 7753, 1915; abst. J. S. C. I. 1916, **35**, 754.
23. U. S. P. 1256981, 1918; abst. J. S. C. I. 1918, **37**, 284-A. F. P. 481149, 1916; abst. J. S. C. I. 1917, **36**, 164. E. P. 128781; abst. J. S. C. I. 1919, **38**, 520-A.
24. U. S. P. 1283087, 1918.
25. Can. P. 183806, 1918.
26. D. R. P. 314119, 1917; abst. J. S. C. I. 1920, **39**, 227-A.
27. E. P. 117887.
28. E. P. 111913; abst. J. S. C. I. 1918, **37**, 24-A.
29. E. P. 128873; abst. J. S. C. I. 1919, **38**, 520-A.
30. E. P. 119854; abst. J. S. C. I. 1919, **38**, 496-A.

ter,¹ H. Ives,² A. Jacobsson and L. McOmber,³ V. de Karavodine,⁴ W. Kelley,⁵ J. Mason,⁶ Middleton, Mills and Zoeochrome, Ltd.,⁷ F. Norman, F. Willmot, T. Dawe and W. Buchanan-Taylor,⁸ C. Rearick,⁹ Soc. Anon. la Cellophane,¹⁰ Smith,¹¹ H. Shorrocks,¹² Tessler,¹³ A. Trivelli,¹⁴ E. Whitmore,¹⁵ W. Wedger,¹⁶ and A. Wyckoff and M. Handschiegl.¹⁷

The mechanical details of continuous photographic film production is without the province of this developmental analysis. Those interested in this portion of the photographic art should refer to the contributions of J. Adda,¹⁸ Act.-Ges. f. Anilinfabrikation,¹⁹ C. Anthoni,²⁰ F. Anthony,²¹ F. Archer,²² G. Baj,²³ G. Balagny,²⁴ A. Baron and C. Guinard,²⁵ Farbenf. vorm. F. Bayer & Co.,²⁶ T. Blair,²⁷ F. Blaisdell,²⁸ G. Bonwitt,²⁹ B. Borzykowski,³⁰ C. Boys,³¹

1. U. S. P. 1139680, 1139681, 1139682, 1139683, abst. C. A. 1915, **9**, 1723. U. S. P. 1149443; abst. C. A. 1915, **9**, 2698. U. S. P. 1192121, abst. J. S. C. I. 1916, **35**, 944.
2. Airplane Photography, 1920, 133.
3. Can. P. 184055, 1918.
4. F. P. 477684, 1914.
5. E. P. Appl. 17002, 1919; abst. J. S. C. I. 1919, **38**, 520-A. U. S. P. 1278162, 1918; abst. J. S. C. I. 1919, **38**, 234-A.
6. E. P. 143230, 1920.
7. E. P. Appl. 17889, 1919; abst. J. S. C. I. 1919, **38**, 560-A.
8. F. P. 21778, 1913; abst. C. A. 1915, **9**, 763.
9. U. S. P. 1255338, 1918.
10. E. P. 2411, 1915; abst. J. S. C. I. 1915, **34**, 983.
11. E. P. Appl. 4390; abst. J. S. C. I. 1919, **38**, 162-A.
12. U. S. P. 1303506, 1919; E. P. 111054, 1917; abst. J. S. C. I. 1917, **36**, 1290; 1919, **38**, 479-A.
13. U. S. P. 1122554; abst. C. A. 1915, **9**, 516.
14. U. S. P. 1205822, 1916; E. P. 7956, 1915; abst. J. S. C. I. 1916, **35**, 754; 1917, **36**, 101.
15. U. S. P. 1255257, 1918.
16. J. Ind. Eng. Chem. 1919, **11**, 893; abst. C. A. 1919, **13**, 2448.
17. U. S. P. 1303836, 1303837, 1919; E. P. 126745, 1917; abst. J. S. C. I. 1919, **38**, 479-A, 554-A.
18. F. P. 442095, 1912.
19. E. P. 9962, 1904; abst. J. S. C. I. 1905, **24**, 248. D. R. P. 134903.
20. E. P. 3024, 1860.
21. U. S. P. 726614, 1903; abst. J. S. C. I. 1903, **22**, 709.
22. E. P. 1914, 1855.
23. E. P. 5077, 1911.
24. E. P. 4178, 1890.
25. F. P. 472671, 1913.
26. E. P. 17009, 1909. D. R. P. 210360, 1908.
27. E. P. 4627, 5504, 1893. T. Blair and S. Waterman, U. S. P. 588790, 1897. Can. P. 45922, 1894.
28. E. P. 639, 1905.
29. Zelluloid-Industries (Gummi-Ztg.) 1913, **8**, 156; abst. Kunst. 1914, **4**, 33.
30. U. S. P. 1090679; abst. J. S. C. I. 1914, **33**, 417. E. P. 4601, 1913;

- J. Brandenberger,¹ E. Bush,² W. Caldwell,³ W. Campbell-Callender,⁴ J. Chorley,⁵ Cie Generale de Phonographes, Cinematographes et Appareils de Precision,⁶ L. Cornides,⁷ F. Cossitt,⁸ F. Crane,⁹ J. Cummings,¹⁰ W. Daniels,¹¹ H. Danzer,¹² E. Dubois,¹³ E. Dupuis,¹⁴ G. Eastman,¹⁵ J. Edsen,¹⁶ B. Edwards,¹⁷ C. Few,¹⁸ J. France,¹⁹ F. Fritz,²⁰ O. Fulton,²¹ S. Halen,²² G. Hùe,²³ Itala-Film-Ing. Sciamengo & Pastrone,²⁴ E. Lane and W. Pettie,²⁵ L. Lilienfeld,²⁶
- abst. J. S. C. I. 1914, **33**, 349. F. P. 454692; abst. Kunst. 1913, **3**, 417; J. S. C. I. 1913, **32**, 865. D. R. P. 281424; abst. Kunst. 1915, **5**, 57.
31. E. P. 22886, 1912.
 1. E. P. 13328, 1909; abst. J. S. C. I. 1909, **28**, 1223. E. P. 15190, 15281, 1909; abst. J. S. C. I. 1910, **29**, 83, 147. E. P. 3929, 1912; abst. J. S. C. I. 1913, **32**, 283; Kunst. 1913, **3**, 295. E. P. 4064, 4065, 4066, 1912; abst. Kunst. 1913, **3**, 295, 332; J. S. C. I. 1912, **31**, 1119; C. A. 1913, **7**, 2856. E. P. 13072, 1914. U. S. P. 991267; abst. J. S. C. I. 1911, **30**, 679. U. S. P. 984886; abst. J. S. C. I. 1911, **30**, 385; C. A. 1911, **5**, 1564. U. S. P. 981368; abst. J. S. C. I. 1911, **30**, 126. U. S. P. 1002634; abst. J. S. C. I. 1911, **30**, 1156. U. S. P. 1049658. D. R. P. 230558; abst. C. A. 1911, **5**, 2600. D. R. P. 239060; abst. C. A. 1912, **6**, 2169; cf. C. A. 1911, **5**, 2330, 3910. F. P. 438774 and addn. 16653 thereto; abst. J. S. C. I. 1913, **32**, 358; Kunst. 1912, **2**, 336; 1913, **3**, 295. F. P. 414594.
 2. E. P. 22674, 1898.
 3. E. P. 1689, 1908; F. P. 397026, 1908; abst. J. S. C. I. 1909, **28**, 259, 746.
 4. E. P. 12375, 1890; abst. Phot. News, 1890, **34**, 637.
 5. U. S. P. 634571, 641623.
 6. E. P. 21099, 1909; F. P. 414050, 426251; Belg. P. 199714, Can. P. 128798, 1910.
 7. Phot. News, 1886, **30**, 444.
 8. U. S. P. 864123, 1907.
 9. E. P. 10393, 1889.
 10. E. P. 24246, 1904.
 11. E. P. 24556, 1909; U. S. P. 987437.
 12. F. P. 414302; abst. Kunst. 1911, **1**, 58.
 13. Belg. P. 204520, 1907.
 14. E. P. 25165, 1907. F. P. 421314, 1909.
 15. U. S. P. 441831, 1890; 471469, 1892. E. P. 3530, 1887; abst. Phot. News, 1887, **31**, 698. E. P. 19658, 1889; abst. Phot. News, 1890, **34**, 973. E. P. 19896, 1889; abst. Phot. News, 1890, **34**, 382. E. P. 19897, 1889; abst. Phot. News, 1890, **34**, 443. G. Eastman and W. Walker, U. S. P. 358848, 1887. See also U. S. P. 306504, 306470, 1884; 368223. G. Eastman, D. R. P. 54214, 1889; Jahr. Chem. 1890, **43**, 2017.
 16. Brit. J. Phot. 1884, **31**, 235.
 17. E. P. 11945, 1890; 19437, 1902. U. S. P. 460570, 1891.
 18. E. P. 19588, 1896.
 19. U. S. P. 498257, 1893.
 20. D. R. P. 218324; abst. Wag. Jahr. 1910, **56**, II, 533; Chem. Ztg. Rep. 1910, **34**, 232.
 21. E. P. 22426, 1910.
 22. Kunst. 1914, **4**, 343; abst. C. A. 1915, **9**, 274. (A review of the patents relating to film manufacture.)
 23. F. P. 387791, 1907.
 24. F. P. 435082, 1911.
 25. E. P. 6886, 1913.
 26. Aust. P. Ann. 6211, 1911.

W. Loebel,¹ E. Mertens,² F. Michael,³ O. Moh,⁴ E. Oeser,⁵ V. Planchon,⁶ M. Ratignier and H. Pervillac et Cie,⁷ H. Reichenbach,⁸ F. Rowell,⁹ C. Sciamengo,¹⁰ H. Sironi,¹¹ Soc. anon. nouvelle I'Oyonnithé and H. du Boistesselin,¹² Soc. anon. des Placques et Papiers Photographiques A. Lumière et ses Fils,¹³ Société civile des Pellicules Nouvelles pour Cinématographes et autres Usages,¹⁴ Soc. gen. des Films and C. Gonon,¹⁵ Soc. Ind. de Photographie,¹⁶ L. Sollier,¹⁷ C. Soulier,¹⁸ J. Stevens and M. Jefferts,¹⁹ Swan & Leslie,²⁰ F. Thompson,²¹ J. Thornton,²² E. Todd,²³ The Unbreakable (Kinematograph) Film Syndicate, Ltd.,²⁴ Voltz, Weiss & Co,²⁵ F. Vogel,²⁶ W. Walker,²⁷ J. Wellington,²⁸ M. Werthen,²⁹ O. Wintermeyer,³⁰ and others.³¹

1. E. P. 14590, 1912.
2. E. P. 17199, 1904.
3. D. R. P. 156339, 1903.
4. U. S. P. 645209, 1900.
5. D. R. P. 209396.
6. U. S. P. 448364.
7. U. S. P. 947457, 1910; E. P. 28538, 1908; F. P. 395219, 395665, 1908; D. R. P. 218010; abst. Wag. Jahr. 1910, **56**, II, 590.
8. U. S. P. 417202, 1889; 599631, 1898, see Brit. J. Phot. 1899, **46**, 498. E. P. 4445, 1898. D. R. P. 149828, 1901. H. Reichenbach and S. Passavant, U. S. P. 458663; abst. J. A. C. S. 1891, **13**, 239.
9. U. S. P. 415566, 1889.
10. U. S. P. 1036730, 1912.
11. F. P. 438245, 438246, 1911.
12. F. P. 420083, 1910.
13. E. P. 16115, 1908; F. P. 350187, 1904, 400739, 1908.
14. F. P. 384111, 1907 and additions 8470, 8471, 8474, 9465 thereto; abst. J. S. C. I. 1908, **27**, 1220.
15. F. P. 388756, 1907.
16. F. P. 430086; abst. J. S. C. I. 1911, **30**, 1308; Kunst. 1912, **2**, 35.
17. U. S. P. 1028296, 1912.
18. E. P. 404795.
19. E. P. 573928, 1896; 600824, 1898.
20. E. P. 9893, 1890.
21. U. S. P. 939350, 1909; 960437, 1910; 970972, 1910. F. P. 408554, 1909.
22. U. S. P. 884082, 1901. E. P. 5793, 1899; abst. Brit. J. Phot. 1900, **47**, 232. F. P. 377579, 1907; 459123, 1913. E. P. 11033, 21180, 1906.
23. U. S. P. 428654, 1890; 483701, 1892. E. P. 9315, 1890.
24. F. P. 462655, 1913.
25. F. P. 321397, 1902.
26. Phot. Mitt. 1898, **35**, 125.
27. E. P. 4214, 1893.
28. E. P. 1573, 1896.
29. F. P. 467988, 1914.
30. U. S. P. 1022617, 1912.
31. See D. R. P. 162044. Act.-Ges. Anilinfabrikation, E. P. 2770, 1900. Gewerbebl. Bayern, 1890, **23**, 119. Phot. News, **36**, 86. D. R. P. 156239. For methods of cleaning nitrocellulose continuous films see H. Colbyson and A. Dworsky, U. S. P. 1230120, 1917. C. Conner, U. S. P.

* *Stripping Films.*¹ In stripping a collodion film from a negative, undoubtedly the first successful process is that of F. Archer.² This was followed by the methods of L. Angamarre,³ M. Arents,⁴ Auer,⁵ A. Barratt and A. Hill,⁶ W. Bailey,⁷ E. Bierstadt,⁸ W. Blair,⁹ Boivin,¹⁰ Cadot,¹¹ Caron,¹² Cassagne,¹³ Ceviale,¹⁴ J. Clive,¹⁵ Dallas,¹⁶ M. Dutkiewicz,¹⁷ and C. Fabre,¹⁸ in which the collodion print was first prepared on glass and then placed on a fabric or other material after stripping. The photographic stereoscope pictures

1202165, 1916. E. Ducher, U. S. P. 1221704, 1917. B. Greene, U. S. P. 1156994, 1915. M. Handschagl, U. S. P. 1334655, 1920. R. Hanish, U. S. P. 1324350, 1919. F. Hochstetter, U. S. P. 1227138, 1914. H. Russak and O. Hanstein, U. S. P. 1208664, 1916. J. Leland, U. S. P. 1165265, 1915. C. deMoos, U. S. P. 1219721, 1915. M. Noble, U. S. P. 1239295, 1917. E. Pearson and C. Jones, U. S. P. 1225270, 1917. M. Robinson, U. S. P. 1199424, 1916. M. Rosenfeld, U. S. P. 1273928, 1281841, 1918. J. Schab, U. S. P. 1162812, 1915. R. Scheiblein, U. S. P. 1300656, 1919. E. Shue, U. S. P. 1189633, 1916. J. Singleton and S. White, U. S. P. 1205039, 1916. J. Tessier, U. S. P. 1205583, 1916. A. Trivelli, U. S. P. 1203548, 1916; 1205822, 1916. J. Vose and W. Owens, U. S. P. 1218137, 1917. Zentrale für Wissenschaftliche u. Schul-Kinematographie, F. P. 473550, 1914.

1. E. G., Rev. Sci. 1918, **56**, 244; abst. C. A. 1919, **13**, 541. Neue Photographische Ges., F. P. 10898, 1904; F. P. 345033, 1904; abst. J. S. C. I. 1904, **23**, 1238; 1905, **24**, 346; F. P. 21584, 1906; F. P. 345033, 345583; abst. J. S. C. I. 1907, **26**, 280, 435; C. A. 1907, **1**, 1827, 1928. Compare Photography, 1891, **3**, 126. Phot. Wochenbl. **18**, 52. Mon. Phot. 1867-1868, **7**, 144. Phot. Archiv. **29**, 159; abst. Indl. 1889, 247; Chem. Tech. Rep. 1889, **28**, I, 151. Phot. Corr. 1870, 186; abst. Chem. Tech. Rep. 1870, **9**, II, 87. Phot. Ann. 1897, 188. Sci. Amer. Suppl. 1880, 3439. Amat. Phot. 1903, **38**, 199. Phot. Bull. 1890, **11**, 10, 85. Chem. Ztg. 1883, **7**, 405. Phot. Mitth. 1889, **5**, 106; 1891-1892, **28**, 193; 1893, **29**, 101. Jahr. Phot. 1900, **14**, 600. Phot. News, 1860, **3**, 394; 1878, **22**, 508; 1880, **24**, 382, 1882, **26**, 556; 1887, **31**, 766; 1900, **44**, 430; 1899, **43**, 591; 1900, **44**, 399; 1906, **50**, 761. Brit. J. Phot. 1863, **10**, 386; 1864, **15**, 106; 1866, **13**, 187; 1874, **21**, 144, 371; 1880, **27**, 422; 1895, **42**, 817; 1896, **16**, 164; 1899, **46**, 261; 1900, **47**, 739. Brit. J. Annual, 1888, 395; 1889, 500; 1891, 563; 1912, 586.

2. E. P. 1914, 1855; abst. Dingl. Poly. 1856, **139**, 192; Lond. Jour. **3**, 291. Bull. Soc. Franc. Phot. 1856, **2**, 34. Jahr. Chem. 1856, **9**, 193; Horn's Phot. J. 1856, No. 1.

3. E. P. 1159, 1856.

4. Brit. J. Phot. 1880, **27**, 318.

5. Dingl. Poly. 1856, **139**, 194; Poly. Centr. 1856, **22**, 753.

6. E. P. 19810, 1893; abst. Phot. News, 1894, **38**, 656.

7. Phot. News, 1881, **25**, 244.

8. Anthony's Phot. Bull.; abst. Phot. News, 1876, **20**, 99.

9. Brit. J. Phot. 1869, **16**, 216.

10. Phot. News, 1875, **19**, 98.

11. Chem. Tech. Rep. 1878, **17**, II, 165.

12. Bull. Soc. Franc. Phot. 1856, **2**, 133.

13. Bull. Soc. Franc. Phot. 1856, **2**, 177.

14. Bull. Soc. Franc. Phot. 1860, **12**, 58.

15. E. P. 2139, 1855.

16. Amer. J. Sci. (Sill.), 1852, (2), **14**, 288; abst. Jahr. Chem. 1862, **5**, 219.

17. Brit. J. Phot. 1871, **18**, 64.

18. Mon. Phot. 1864-1865, **4**, 66.

of J. Ferrier,¹ and the communications of Fortier,² E. Foxlee,³ Gaillard,⁴ A. Gaudin,⁵ J. Glover and J. Bold,⁶ Grune,⁷ H. Gunther,⁸ W. Harrison,⁹ A. Hill and A. Barratt,¹⁰ Howell,¹¹ J. Hutchinson,¹² M. Jeanrenaud,¹³ Karasek,¹⁴ F. Kent and T. Middleton,¹⁵ J. Kruger,¹⁶ G. Kyrkow,¹⁷ Lainer,¹⁸ E. Lucas,¹⁹ P. Mandel,²⁰ Marion,²¹ Marville,²² R. Morris,²³ W. Newton,²⁴ Obernetter,²⁵ Otto,²⁶ W. Paul,²⁷ L. Piron-Raulin,²⁸ A. Rollason,²⁹ C. Rosier,³⁰ Ross,³¹ Roy,³² G. Rydill,³³ O. Sarony,³⁴ Scamoni,³⁵ F. Schmalz,³⁶ J. Schnauss,³⁷ F. Wenderoth,³⁸

1. E. P. 2315, 1857.
2. Brit. J. Phot. 1875, **22**, 82.
3. U. S. P. 495458, 1893; E. P. 15727, 1866; abst. Phot. News, 1887, **31**, 698.
4. Bull. Soc. Franc. Phot. 1855, **1**, 337.
5. Dingl. Poly. 1855, **137**, 462; Poly. Centr. 1856, **22**, 506, Horn's Phot. J. 1855, **4**, No. 5.
6. E. P. 501, 1857.
7. Bull. Soc. Franc. Phot. 1870, **16**, 237.
8. Phot. News, 1890, 75, 497.
9. Brit. J. Phot. 1879, **26**, 182.
10. E. P. 15217, 1895; abst. Brit. J. Phot. 1895, **42**, 429.
11. Bull. Soc. Franc. Phot. 1859, **5**, 26.
12. Brit. J. Phot. 1869, **16**, 516.
13. Phil. Photographer, Brit. J. Phot. 1872, **19**, 115.
14. Brit. J. Phot. 1897, **44**, 347.
15. E. P. 29616, 1912; 12091, 1915; abst. J. S. C. I. 1914, **33**, 221, 1916, **35**, 1035.
16. Chem. Tech. Rep. 1878, **17**, II, 165.
17. Phot. Corres. Phot. News, 1895, **39**, 76.
18. Brit. J. Phot. 1897, **44**, 423.
19. E. P. 11120, 1912; abst. C. A. 1913, **7**, 3723. Compare E. P. 18965, 1911; abst. C. A. 1913, **7**, 456.
20. Phot. News, 1890, **34**, 1008.
21. Bull. Soc. Franc. Phot. 1865, **15**, 36; 1869, **15**, 36.
22. Bull. Soc. Franc. Phot. 1857, **3**, 31.
23. E. P. 2029, 1856.
24. Cosmos, **4**, 766; abst. Poly. Centr. 1854, **20**, 1266.
25. Phot. News, 1880, **24**, 505.
26. Phot. News, 1885, **29**, 273.
27. Brit. J. Phot. 1876, **23**, 205.
28. F. P. 396759, 1908.
29. E. P. 770, 1855; abst. Lond. Jour. (N. S.), **3**, 27, Mechn. Mag. **64**, 132.
30. E. P. 16560, 1910.
31. Bull. Soc. Franc. Phot. 1858, **4**, 278.
32. Brit. J. Phot. 1898, **45**, 773.
33. Brit. J. Phot. 1885, **32**, 11.
34. E. P. 725, 1858.
35. Bull. Soc. Franc. Phot. 1870, **16**, 325.
36. U. S. P. 409507, 1889.
37. Dingl. Poly. 1860, **154**, 431; 1863, **167**, 235; abst. Chem. Centr. 1860, **31**, 1023; Poly. Centr. 1863, **29**, 448; Phot. Archiv. 1862, 224.
38. Brit. J. Phot. 1864, **11**, 195.

•Taylor,¹ A. Thiebaut,² Toulouse,³ J. Turnbull,⁴ E. Valenta,⁵ L. Vidal,⁶ E. Vogel,⁷ L. Warnerke,⁸ F. Wenderoth,⁹ and W. Woodbury,¹⁰ give details of the development of this phase of collodion photography.

Halation and Solarization. The use of collodion varnishes and lacquers to prevent halation (local over-exposure) and solarization (reversal of the image) has been extensive. Especially in the backing of plates, either colorless or dyed collodion has found wide uses. The methods of application, dyeing and manipulation of pyroxylin and celluloid for these purposes, are to be found¹¹ in the writings and patented processes of J. Baldock,¹² W. Bolton,¹³ Bremer Trockenplatten Fabrik B. Klatte,¹⁴ S. Comanari,¹⁵ H. Cooper,¹⁶ Cornu,¹⁷ G. Dawson,¹⁸ Ducos du Hauron,¹⁹ E. Lanry,²⁰ Lamy,²¹ M. Lea,²² Le Roy,²³ H. Maclean,²⁴ G. Marlow,²⁵

1. Phot. Archiv. 1863, 298; abst. Chem. Tech. Rep. 1863, **2**, II, 71.
2. E. P. 1608, 1883.
3. Bull. Soc. Franc. Phot. 1860, **6**, 117; abst. Brit. J. Phot. 1860, **7**, 193.
4. Phot. News, 1887, **31**, 372.
5. Phot. Corr.; abst. Brit. J. Phot. 1896, **43**, 460.
6. Brit. J. Phot. 1869, **16**, 627.
7. Bull. Soc. Franc. Phot. 1867, **13**, 50. Phot. Mitth. 1867, **3**, 171; 1889 1890, **26**, 312. Phot. News, 1876, **20**, 158. Brit. J. Phot. 1878, **25**, 498, 1898, **45**, 519.
8. Phot. News, 1881, **25**, 218.
9. Brit. J. Phot. 1864, **11**, 184.
10. Brit. J. Phot. 1867, **14**, 325, 1868, **15**, 480, Bull. Soc. Franc. Phot. 1867, **13**, 23. E. P. 2921, 1878.
11. Phot. Nach. 1890, **2**, 204; abst. Chem. Ztg. Rep. 1890, **14**, 122; Chem. Tech. Rep. 1890, **29**, I, 167. Amer. Annual Phot. 1892, 148. Amat. Phot. 1898, **27**, 288; 1900, **31**, 414, 1910, **51**, 591. Phot. Mitth. 1889, **6**, 47. Phot. News, 1860, **5**, 157; 1887, **31**, 225; 1890, **34**, 467; 1901, **45**, 535; 1908, **53**, 197. Brit. J. Phot. 1861, **8**, 148, 1864, **11**, 362, 487; 1868, **15**, 276, 596; 1873, **20**, 299; 1874, **18**, 40, 1877, **24**, 280, 1883, **30**, 459, 1897, **44**, 450, 542, 552, 606; 1912, **59**, 217.
12. Brit. J. Phot. 1897, **44**, 639.
13. Brit. J. Phot. 1875, **22**, 223, 1897, **44**, 542.
14. E. P. 11341, 1908, E. P. 390572, 1908; abst. J. S. C. I. 1908, **27**, 1223.
15. U. S. P. 1305195, 1919, E. P. 469218, 1914; abst. J. S. C. I. 1915, **34**, 50, 1919, **38**, 554-A.
16. Brit. J. Phot. 1872, **19**, 387.
17. Phot. News, 1890, **34**, 353; 1906, **50**, 11.
18. Brit. J. Phot. 1881, **28**, 661.
19. Brit. J. Phot. 1897, **44**, 552.
20. Brit. J. Phot. 1879, **23**, 31.
21. Mon. Phot. 1879, **18**, 11; Bull. Soc. Franc. Phot. 1879, **25**, 20.
22. Brit. J. Phot. 1868, **15**, 367; 1870, **17**, 360, 1874, **21**, 212.
23. Brit. J. Phot. 1897, **44**, 552.
24. Brit. J. Phot. 1897, **44**, 458, 504.
25. Brit. J. Phot. 1861, **8**, 141; 1864, **11**, 416, 470, 1865, **12**, 43; 1868, **15**, 312; 1898, **45**, 139, 149.

Nicol,¹ G. Penny,² N. Pepper,³ C. Pettitt,⁴ J. Pike,⁵ P. Plymley,⁶ J. Pollitt,⁷ A. Ranyard,⁸ T. Roche,⁹ C. Russell,¹⁰ J. Sandell,¹¹ J. Spiller,¹² F. Stolz,¹³ T. Sutton,¹⁴ E. Vogel,¹⁵ G. van Walsem,¹⁶ and G. Webster.¹⁷

Celluloid Film Varnishes. The general subject of pyroxylin lacquers is discussed in detail in Vol. III of this series, and celluloid varnishes in Vol. V. Especially in connection with photographic practice, attention should be directed to the art of applying to the front of the negative of a cellulose nitrate coating to prevent or minimize the action of dampness. Specific details of this branch of the art are to be found¹⁸ in the communications of Barker,¹⁹ Bienert,²⁰ F. Blaisdell,²¹ V. Bloede,²² A. Bogue,²³ A. Bolas,²⁴ W. Bolton,²⁵

1. Brit. J. Phot. 1878, **25**, 506
2. Brit. J. Phot. 1868, **15**, 296
3. Phot. News, 1875, **19**, 597
4. E. P. 8956, 1893; abst. J. S. C. I. 1893, **12**, 185. Compare E. P. 4606, 1894; abst. J. S. C. I. 1894, **13**, 303, 1895, **14**, 100, 185
5. Pract. Photog. 1891, 169, abst. Brit. J. Phot. 1897, **44**, 537
6. Brit. J. Phot. 1868, **15**, 585
7. Brit. J. Phot. 1880, **27**, 617
8. Brit. J. Phot. 1874, **21**, 355. Compare Atkin, Nature, **10**, 185
9. U. S. P. 519646, 1894. In this connection see T. Roche, U. S. P. 519645, 1894.
10. Brit. J. Phot. 1864, **11**, 495, abst. J. S. C. I. 1891, **10**, 1052; 1892, **11**, 1056; 1893, **12**, 61.
11. E. P. 21381, 1891.
12. Phot. News, 1874, **18**, 189
13. Brit. J. Phot. 1881, **28**, 398, Phot. News, 1882, **26**, 536.
14. Brit. J. 1874, **21**, 307
15. Phot. Mitth. 1893, **30**, 282, 1897, **34**, 126, Bull. Soc. Franc. Phot. 1897, **13**, 467; Brit. J. Phot. Aug. 27, 1897
16. Int. Phot. Monat. Med. 1900, **7**, 217, abst. Chem. Ztg. Rep. 1901, **25**, 8; J. S. C. I. 1901, **20**, 278
17. Brit. J. Phot. 1897, **44**, 501, 566.
18. Anat. Phot. 1890, **12**, Q. 352, A. 461, 1893, **17**, 240. Eder's Jahrb. Phot. 1890, **4**, 318, 497; 1895, 498; 1906, 524, 1910, 636, 1911, **25**, 155, 384, 486, 537; 1914, 224. Neues Erfind. Erfah. 1906, **33**, 89. Photography 1898, **10**, 488; 1900, **12**, 300, 344, 1901, **13**, 865, 1902, **14**, 238. Brit. J. Annual, 1892, 551; 1894, 68; 1898, 670, 1907, 827, 971; 1911, 555. Phot. Mitth. 1870, **6**, 219; 1882, **18**, SR 15. Phot. Times, 1891, 98, **18**, 164. See Brit. J. Phot. 1892, **39**, 115, 1869, **16**, 275, 1871, **18**, 239, 569, 1874, **21**, 533; 1877, **24**, 91; 1878, **25**, 575, 1881, **28**, 299; 1882, **26**, 161, 668, 1892, **39**, 170; 1897, **44**, 725, 1899, **45**, 119; 1898, **45**, 644; 1899, **46**, 243, 1909, **56**, 209, 274, 1911, **58**, 352. Brit. J. Phot. Color Suppl. 1907, **1**, 86. Phot. News, 1870, **20**, 503; 1887/79, **23**, 133; 1882, **26**, 238; 1886, **30**, 415; 1890, **34**, 602; 1896, **40**, 506; 1899, **43**, 631; 1900, **44**, 739, 1901, **45**, 303; 1902, **46**, 791; 1905, **49**, 393; 1905, **49**, 424; 1906, **50**, 541, 675, 781, 929, 1908, **53**, 384.
19. Bull. Soc. Franc. Phot. 1877, **23**, 58
20. Brit. J. Phot. 1868, **15**, 432
21. E. P. 639, 1905.
22. Phot. News, 1868, **12**, 128.
23. Phot. Corres. Phot. News, 1875, **19**, 164.

D. Carvalho,¹ B. Conelly,² H. Cotesworth,³ Crane Chemical Co.,⁴ L. Crozat,⁵ R. Dockree,⁶ T. Doughty,⁷ C. Düren,⁸ Eilenburger Celluloidstoffabrik,⁹ Evans,¹⁰ M. Frank,¹¹ Grenier Art Co.,¹² H. Gunther,¹³ E. Hough,¹⁴ Jarman,¹⁵ P. Laujorrais,¹⁶ J. Lowinsky,¹⁷ L. Marten,¹⁸ Micke,¹⁹ D. v. Manckhoven,²⁰ J. Morgeneier,²¹ Plohn,²² Remond,²³ F. Springmuhl,²⁴ Stroblberger,²⁵ H. Tesch,²⁶ J. Ungar,²⁷ E. Valenta,²⁸ L. Vidal,²⁹ F. Wachendorf,³⁰ C. Waldeck,³¹ G. Webster,³² R. Whiting,³³ W. Wilkinson,³⁴ and W. Wood.³⁵

Pyroxylin Flash Light Powder. The earlier flash light compositions for photographic use contained combinations of chlor-

24. Phot. News, 1880, **24**, 306.
25. Brit. J. Phot. 1890, **37**, 371.
1. U. S. P. 225458, 1880.
2. Phot. News, 1906, **50**, 107.
3. Brit. J. Phot. 1883, **30**, 356; 1884, **31**, 470.
4. Products called 'Enameline' and 'Protectaline,' Phot. News, 1889, **33**, 176.
5. E. P. 2953, 1864.
6. E. P. 15841, 1909.
7. Brit. J. Phot. 1880, **27**, 30.
8. F. P. 448860, 1912; abst. J. S. C. I. 1913, **32**, 451.
9. Eder's Jahr. 1900, 693.
10. Phot. News, 1898, **42**, 414.
11. Wiener Mitth. 1907, 399; abst. C. A. 1908, **2**, 512.
12. E. P. 13317, 1900; abst. J. S. C. I. 1900, **19**, 807, 1068.
13. Phot. News, 1893, **37**, 313.
14. Brit. J. Phot. 1870, **14**, 267; 1875, **22**, 272. See also Phot. News, 1881, **25**, 587.
15. Wilson's Mag. 1907, **44**, 338.
16. E. P. 4195, 1873.
17. Belg. P. 184801, 1905.
18. U. S. P. 439021, 1890.
19. Phot. Mitth. 1902, **39**, 59.
20. Phot. News, 1863, **7**, 233. Brit. J. Phot. 1871, **18**, 471.
21. U. S. P. 109833, 1873; and Re. 5618.
22. Brit. J. Phot. 1878, **25**, 452.
23. Brit. J. Phot. 1906, **53**, 651.
24. Must. Ztg.; abst. Phot. News, 1872, **16**, 636.
25. Chem. Tech. Rep. 1869, **8**, 1, 78. Compare Dingl. Poly. 1869, **192**, 73; Poly. Centr. 1869, **35**, 517; Gewerbl. Wurt. 1869, 251; Deut. Ind. Ztg. 1869, 78; Wieck's Gewerztg. 1869, 94.
26. Brit. J. Phot. 1871, **18**, 244.
27. Phot. Corres.; abst. Phot. News, 1874, **18**, 267.
28. Chem. Tech. Rep. 1894, **33**, 1, 145. Compare Indbl. 1893, 391; Chem. Ind. 1893, 468.
29. Phot. News, 1884, **28**, 7; 1889, **33**, 391.
30. E. P. 12460, 1905; abst. J. S. C. I. 1905, **24**, 934.
31. Mosaics; abst. Phot. News, 1879, **23**, 16.
32. Brit. J. Phot. 1883, **30**, 525.
33. Brit. J. Phot. 1905, **52**, 203, 506; Brit. J. Annual, 1906, 849.
34. Brit. J. Phot. 1883, **30**, 239.
35. Phot. News, 1876, **23**, 244.

ates, bichromates, and other chemicals which together formed explosive combinations in conjunction with magnesium. Several fatal accidents in connection with their use, caused replacement of these products by the lower nitrated cellulose nitrates as an adjunct to magnesium.¹ Details of these formulas and processes are shown in the disclosures of J. Bullock and C. Mitchell,² J. Carbutt,³ F. Carter,⁴ C. Claessen,⁵ W. Fuller,⁶ Geka-Werke Offenbach Dr. Krebs,⁷ R. Gilmore,⁸ F. Hart,⁹ W. Harrison,¹⁰ W. Harrison,¹¹ A. Henderson,¹² C. Henry,¹³ W. Hopkinson,¹⁴ J. Hubert,¹⁵ J. Huntrods,¹⁶ A. Jarman,¹⁷ C. Knight,¹⁸ A. Lainer,¹⁹ C. Mitchell,²⁰ H. Piffard,²¹ G. Rau²² and B. Sayce.²³

Collodion in Ceramics. The originator of the use of collodion positive images for the decoration of china is an open question. P. Armand,²⁴ and A. Lafon de Camarsac²⁵ published early processes. Marechal and C. Tessie du Motay²⁶ used sensitive collodion in a collodionized film, toned the image with platinum and gold and then fired it. D. Scotellari,²⁷ preferred enamel collodion; F. Toubert,²⁸ was actually the first to use vitrifiable fluxes in which

1. Phot. News, 1887, **31**, 749, 1888, **32**, 190, 738; 1889, **33**, 62, 77, 110, 1895, **39**, 282. Brit. J. Phot. 1910, **57**, 717. Brit. J. Almanac, 1907, 659. See Eder's Jahr. Phot. 1902, 448. Y. Schwarz, E. P. 5637, 1896.
2. Phot. News, 1890, **34**, 109.
3. Phot. News, 1887, **31**, 790.
4. Phot. News, 1887, **31**, 779.
5. F. P. 410239, 1909; and Addn. 12430, 13235, 18487, thereto.
6. Phot. News, 1888, **32**, 525.
7. D. R. P. 231599, 1905; abst. C. A. 1911, **5**, 2660. Cf. D. R. P. 223922, 228598; abst. C. A. 1911, **5**, 1564.
8. Phot. News, 1888, **32**, 191; 1902, **46**, 201.
9. E. P. 3279, 1889; abst. Phot. News, 1890, **34**, 227.
10. Phot. News, 1888, **32**, 45.
11. Brit. J. Phot. 1887, **34**, 791.
12. Brit. J. Phot. 1897, **44**, 591.
13. D. R. P. 103518; abst. Vag. Jahr. 1899, **45**, I, 102.
14. Phot. News, 1887, **31**, 733.
15. Phot. News, 1888, **32**, 185.
16. Phot. News, 1908, **53**, 156.
17. Wilson Phot. Mag.; abst. Phot. News, 1904, **48**, 695.
18. Phot. News, 1887, **31**, 800.
19. Phot. Corres.; abst. Brit. J. Phot. Suppl. 1899, **46**, 10.
20. Phot. News, 1890, **34**, 191, 225.
21. Phot. News, 1887, **31**, 738; 1888, **32**, 463.
22. Amer. J. Phot.; abst. Brit. J. Phot. 1899, **46**, 313.
23. Phot. News, 1888, **32**, 46.
24. E. P. 2620, 1854.
25. Compt. rend. 1855, **40**, 1266. See Brit. J. Phot. 1864, **11**, 238.
26. E. P. 1060, 1864.
27. E. P. 3130, 1880.
28. E. P. 149, 1860.

there was no collodion. M. Anthes and E. Lloyd¹ have patented the use of nitrocellulose and bichromated honey, similar to the process of Ling, Rendle and Colbrook.²

Other processes along the above lines have been described by³ H. Abbott and W. Garrison,⁴ J. Bailey,⁵ W. Bayley,⁶ A. Chardon,⁷ J. Bonnaud,⁸ M. and R. Charbonnier,⁹ N. Cherrill,¹⁰ P. Duchochois,¹¹ E. Dunmore,¹² E. Edward,¹³ P. Elliff,¹⁴ C. Fleck,¹⁵ F. Forster and G. Rockwood,¹⁶ Albert,¹⁷ W. Gamble,¹⁸ L. Garchey,¹⁹ Geymet,²⁰ C. Greenley and J. Day,²¹ W. Crum,²² A. Henderson,²³ E. Jabulowsky and A. Bourquin,²⁴ F. Joubert,²⁵ J. Lemary,²⁶ A. Ling, T. Rendle, and E. Colbrook,²⁷ C. Marechal and C. Tessie du Motay,²⁸ E. Morgan,²⁹ W. McCraw,³⁰ J. von Norath,³¹ J. Ober-

1. E. P. 24214, 1907; abst. Brit. J. Phot. 1908, **55**, 382.
2. E. P. 17432, 17434, 1908; abst. J. S. C. I. 1909, **28**, 1063.
3. Brit. J. Phot. 1868, **15**, 184; 1869, **16**, 231, 546; 1871, **18**, 214; 1886, **33**, 503. Brit. J. Annual, **10**, 581. Phot. News, 1880, **24**, 399, 411; 1882, **26**, 241; 1884, **28**, 724; 1886, **30**, 780. Jahr. Phot. 1902, **16**, 611. Eder's Jahr. Phot. 1894, 267; 1900, 686; 1902, 611; 1903, 506. See E. P. 6501, 1893.
4. D. R. P. 26072, 1883.
5. E. P. 1294, 1880; abst. Brit. J. Phot. 1880, **27**, 585.
6. Brit. J. Phot. 1869, **16**, 308, 320.
7. Bull. Soc. Franc. Phot. Dec. 1, 1876; abst. Phot. News, 1876, **20**, 583.
8. E. P. 1751, 1888, E. P. 195780, 1889; abst. Phot. News, 1889, **33**, 458; J. S. C. I. 1888, **7**, 156; 1889, **8**, 74, 196.
9. E. P. 3298, 1876.
10. Phot. News, 1878, **22**, 74.
11. Anthony's Bull.; abst. Brit. J. Phot. 1898, **45**, 89.
12. Brit. J. Phot. 1897, **44**, 696.
13. E. P. 2201, 1868.
14. Phot. News, 1902, **46**, 56.
15. Keram. Rundsch. 1910, 397.
16. E. P. 6501, 1893; abst. J. S. C. I. 1893, **12**, 400.
17. Brit. J. Phot. 1868, **15**, 500; 1869, **16**, 320.
18. Phot. News, 1865, **39**, 533.
19. E. P. 19843, 1899; abst. J. S. C. I. 1899, **18**, 968; 1900, **19**, 807, 850, 948.
20. Brit. J. Phot. 1869, **16**, 332.
21. E. P. 16486, 1901.
22. E. P. 3002, 1866.
23. Phot. News, 1877, **21**, 437; 1883, **27**, 162.
24. E. P. 14410, 1905.
25. Brit. J. Phot. 1862, **9**, 101.
26. E. P. 5223, 1879; abst. Brit. J. Phot. 1880, **27**, 429, Phot. News, 1883, **27**, 10.
27. E. P. 17433, 1908; abst. Brit. J. Phot. 1909, **56**, 731; J. S. C. I. 1908, **27**, 592. Cf. E. P. 24214, 1907.
28. E. P. 1060, 1864. See also J. Obernetter, E. P. 2048, 1864.
29. Phot. News, 1897, **41**, 215, 216.
30. E. P. 941, 1870. Brit. J. Phot. 1871, **18**, 4.
31. Deut. Phot. Ztg. 1899, **46**, 7.

netter,¹ S. d'Ostrorog,² C. Pearce,³ Regnault,⁴ T. Rendle⁵ and D. Scotellari,⁶ T. Sims,⁶ J. Slater,⁷ J. Strumper,⁸ C. Thomson,⁴ A. Tournoux and F. Schmalz,¹⁰ G. Wallich,¹¹ and H. White.¹²

*Photomechanical Processes.*¹⁴ In Photolithography, photozincography and similar processes, collodion and celluloid has been used for years and at the present time is extensively employed in several branches of the art. In collotype processes it is essential to use a negative that is laterally reversed, i. e., a negative in which the right hand of the subject is on the right hand of the negative film. Woodbury¹⁵ used a solution of gum arabic, while J. Ferrier,¹⁶ Geymet,¹⁶ Norris,¹⁷ and Gobert¹⁸ preferred gelatin, which, after drying, was coated with leather collodion.¹⁹ A. Weiss²⁰ has patented the use of a celluloid or mica sheet placed over the surface of the negative in a roll. C. Gould²¹ proposes to use two pressed cork rollers celluloid coated. A. Sanderson²² has introduced a flat celluloid sheet for squeegeeing prints or to give them the desired surface. C. Mackenzie²³ patented the use of celluloid

1. U. S. P. 52503, 1866; E. P. 3048, 1864; Brit. J. Phot. 1865, **12**, 561
2. E. P. 10558, 1884
3. Phot. News, 1889, **33**, 479
4. Brit. J. Phot. 1865, **12**, 355
5. E. P. 3130, 1880
6. Phot. News, 1875, **19**, 249
7. E. P. 21081, 1896; abst. J. S. C. I. 1897, **16**, 799, 825
8. D. R. P. 1384, 1877. See also Brit. J. Phot. 1895, **39**, 479
9. E. P. 23815, 1905
10. U. S. P. 260065, 1882
11. Brit. J. Phot. 1872, **19**, 65
12. Phot. News, 1885, **29**, 741
13. Anthony Phot. Bull. 1890, **21**, 453. Brit. J. Phot. 1863, **10**, 130, 1864, **11**, 30; 1865, **12**, 570; 1869, **16**, 536; 1884, **31**, 87, 102, 131, 167, 198, 1896, **43**, 397; 1905, **52**, 792. J. Buchd. 1881, **48**, 336. Penrose's Annual, **8**, 225. Eder's Jahr. Phot. 1890, 343, 1895, 523, 1896, 597, 1896, 599, 1897, 500; 1900, 651; 1901, 636; 1902, 668, 1904, 560, 1909, 458, 1911, 614. Jahr. Phot. Rep. Tech. 1899, 593, Schwz. Graph. Mitth. 1898-1899, No. 5, 477. Phot. News, 1863, **7**, 14; 1901, **45**, 623. Brit. J. Ann. 1896, 822, 1897, 232
14. James and A. Scott, Grav. Hel. **5**, 1536
15. Phot. Archiv. 1868, 242
16. E. P. 2315, 1857
17. Phot. Archiv. 1873, 157
18. Kreutzer's Jahr. 1857, 307
19. Phot. Corr. **9**, 90
20. This was first recommended by Grima, Phot. Mitth. April 1865
21. D. R. P. 140529, 1907
22. E. P. 24525, 1902
23. E. P. 25105, 1903
24. C. Mackenzie and The Institute for Physical and Political Geography, E. P. 3457, 1904

as a support for maps, and molding by heat and pressure the physical contours, such as hills.

Matt and transparent celluloid negatives,¹ opaque and transparent celluloid dishes,² celluloid lacquers for coating photographic negatives,³ and the W. Martin process⁴ for the use of metallic negatives suspended in collodion or celluloid to make flexible envelopes or shields for X-ray tubes, are well known applications. P. Hewitt⁵ prefers cellulose acetate for the same purpose.

L. Boule, A. Bliu and E. Testu⁶ patented the use of a collodion stripping film with castor oil; F. Spitzer⁷ the production of a cross line black and white screen of celluloid, while J. Bruner and C. Klarey⁸ used a gelatin relief for the production of base relief positives on celluloid. L. Collardon and A. Barthel⁹ proposed the use of celluloid as a plastic plate for obtaining photo-mechanical surfaces.

J. Bannaud¹⁰ patented the transference of colored prints obtained by the powder process on celluloid. G. Balagny,¹¹ F. Sautner,¹² and G. Sershall¹³ made similar improvements.

D. Lichtenberg-Madsen¹⁴ produces a swollen gelatin relief from which a plaster cast is made which is transferred to celluloid by heat. O. Fulton and M. Gillard¹⁵ have patented the use of celluloid instead of glass for the collotype process. E. Vogel¹⁶ proposed to print from an ordinary block onto celluloid, and from this to print on a light sensitive asphalt or bichromated collod. J. Paterson, W. Dickson and G. Kerr¹⁷ patent the use

1. P. Hillhouse, E. P. 9515, 1904. Kodak, Ltd., E. P. 24246, 1904
2. B. Edwards, E. P. 14074, 1893.
3. R. Dockree, E. P. 15841, 1909. Compare Grenier Art Co., E. P. 13317, 1900.
4. E. P. 24618, 1904.
5. E. P. 16271, 1911.
6. E. P. 3703, 1877.
7. E. P. 249, 1900.
8. E. P. 13380, 1866; abst. Phot. News, 1887, **31**, 666, 728.
9. E. P. 5595, 1884; abst. J. S. C. I. 1884, **3**, 265.
10. E. P. 4537, 1888; abst. J. S. C. I. 1888, **7**, 364; 1889, **8**, 160, 414.
11. E. P. 4178, 1890; abst. J. S. C. I. 1891, **10**, 572.
12. D. R. P. 87472, 1895; abst. J. S. C. I. 1897, **16**, 716; 1898, **17**, 721.
13. E. P. 3121, 1897. In this connection see G. Sershall and Kirk, E. P. 17122, 1897.
14. E. P. 14814, 1898. U. S. P. 672534, 1901.
15. E. P. 23058, 1899; abst. Amt. Photog. 1902, 385.
16. E. P. 8088, 1900.
17. E. P. 8578, 1900.

of a stripping film of collodion; G. Schreiber and J. Levinstein¹ propose to take impressions from a printing block onto celluloid and rubber sheets; M. Barricelly and C. Levi² use celluloid as a support for stripped negatives for photomechanical printing. Amstutz³ prepares a carbon print from an ordinary negative and places a celluloid sheet over the surface which is pressed into contact, while a wedge shaped knife engraves lines on the celluloid. The processes of C. Lorch⁴ and of G. Fischer⁵ are similar. G. Koppmann⁶ produces photographic reliefs on celluloid and etches with a mixture of amyl acetate and amyl alcohol. A Stephan⁷ has also patented the use of celluloid as a support for litho transfers, and H. Reckard⁸ also claims the use of celluloid as a support.

Other developments of the above and similar ideas are to be found in the disclosures of C. Archer,⁹ H. Strecker-Aufermann,¹⁰ H. Avet,¹¹ W. Batho,¹² A. Bawtree,¹³ F. Beatty and T. Alexander,¹⁴ Benecke & Fischer and J. Frank,¹⁵ T. Bolas,¹⁶ R. Boerner,¹⁷ W. Boorne,¹⁸ A. Brookes,¹⁹ E. and J. Bullock,²⁰ W. Burton,²¹ Capitaine & v. Hertling,²² J. Cheetham,²³ J. Christensen,²⁴ R. Clouston,²⁵

1. E. P. 18593, 1902; abst. J. S. C. I. 1903, **22**, 44.
2. E. P. 19434, 1903; abst. J. S. C. I. 1903, **22**, 1307.
3. Brit. J. Phot. 1902, **49**, 653; 1909, **56**, 86.
4. D. R. P. 126836; abst. Wag. Jahr. 1902, **48**, II, 594.
5. D. R. P. 13417.
6. D. R. P. 132696.
7. E. P. 17967, 1904.
8. E. P. 23990, 1905.
9. E. P. 7853, 1903; abst. J. C. S. I. 1903, **22**, 819. Cf. E. P. 21537 1902.
10. E. P. 3699, 1909. Reference is made to E. P. 28319, 1906. *Fleck-Notizkalender f. Chemigraphen und Reproduction* (Halle, o. S. 1902, 97).
11. E. P. 2110, 1865.
12. Brit. J. Phot. 1875, **22**, 582.
13. E. P. 923, 1915.
14. E. P. 2913, 1860.
15. E. P. 3362, 1883; abst. Brit. J. Phot. 1884, **31**, 154.
16. Brit. J. Phot. 1878, **25**, 471; Phot. News, 1878, **22**, 387.
17. E. P. 19889, 1907; abst. J. S. C. I. 1908, **27**, 140.
18. E. P. 7421, 1909.
19. E. P. 2312, 1884; abst. Phot. News, 1885, **29**, 11.
20. E. P. 2964, 1865; abst. Brit. J. Phot. 1866, **13**, 162.
21. Phot. News, 1895, **39**, 117.
22. D. R. P. 52868, 1889; abst. Ber. 1890, **23**, 671; Wag. Jahr. 1890, **36**, 1089; Mon. Sci. 1890, **36**, 1089. See D. R. P. 112615, 1898.
23. E. P. 2871, 1856.
24. E. P. 25419, 1913; abst. J. S. C. I. 1914, **33**, 1220.
25. E. P. 4454, 1894; abst. Chem. Centr., 1895, **66**, I, 1092.

L. Cornides,¹ W. Cooper,² R. Courtenay,³ Daniel Process Co.,⁴ F. Dent,⁵ P. Despaquis,⁶ O. Dodge,⁷ M. Droitcour,⁸ E. and C. Dupuis,⁹ L. Errera,¹⁰ and including the work of P. Gaultier,¹¹ Guilbot and Heritier,¹² H. Gunther,¹³ J. and L. Hartnett,¹⁴ F. Hausleiter,¹⁵ S. Horgan,¹⁶ J. Ippers,¹⁷ Jacobsen,¹⁸ M. Jaffe,¹⁹ F. Kossuth,²⁰ R. Krayn,²¹ O. Kull,²² F. Kunkler,²³ W. Lang,²⁴ E. La-porte,²⁵ J. Lewis,²⁶ W. Leggo,²⁷ E. Lucas,²⁸ B. Ludwig,²⁹ J. Magne,³⁰ W. McCraw,³¹ H. Mendelsohn,³² Merget,³³ F. Miller and Miller-graph Co.,³⁴ W. Newton,³⁵ L. Orans,³⁶ C. Pahner,³⁷ A. Payne,³⁸ G.

1. E. P. 1171, 1856.
2. E. P. 26715, 1905.
3. E. P. 2848, 1872.
4. E. P. 7123, 1900.
5. E. P. 16069, 1890, abst. Phot. News, 1890, **34**, 812.
6. U. S. P. 185673, 1876.
7. U. S. P. 758625, 1904, 874885, 1907, E. P. 14858, 1907; F. P. 379497, 1907, abst. Brit. J. Phot. 1908, **55**, 220.
8. U. S. P. 912093, 1909, 960006, 1910, E. P. 11225, 1911; abst. Brit. J. Phot. 1912, **59**, 443.
9. E. P. 27482, 1910.
10. E. P. 20660, 1898.
11. E. P. 6093, 1907; abst. Brit. J. Phot. 1908, **55**, 587.
12. Brit. J. Phot. 1866, **13**, 380.
13. Phot. News, 1890, **34**, 471.
14. E. P. 6793, 1909.
15. D. R. P. 236275, 1909, abst. C. A. 1912, **6**, 1890, Brit. J. Phot. 1909, **56**, 953.
16. U. S. P. 341332, 1886.
17. E. P. 26965, 1905, abst. Brit. J. Phot. 1907, **54**, 104.
18. Brit. J. Phot. 1869, **16**, 489.
19. Phot. News, 1888, **32**, 431, 493.
20. E. P. 449, 1865.
21. E. P. 58, 1907.
22. Swiss P. 26386, 1902.
23. D. R. P. Jan. 29, 1884; abst. Phot. Mitth. Brit. J. Phot. 1885, **32**, 620.
24. Brit. J. Phot. 1884, **31**, 204, 219; Phot. News, 1884, **28**, 199; 1886, **30**, 841; 1887, **31**, 17.
25. E. P. 19721, 1907; D. R. P. 196251, abst. Wag. Jahr. 1908, **54**, II, 497.
26. E. P. 1936, 1861.
27. E. P. 340, 1871.
28. E. P. 11120, 1912, abst. C. A. 1913, **7**, 3723. See also E. Lucas, E. P. 18965, 1911; abst. C. A. 1913, **7**, 456.
29. U. S. P. 747738, 1903.
30. E. P. 3762, 1881; abst. Brit. J. Phot. 1882, **29**, 361.
31. E. P. 941, 1870.
32. U. S. P. 550079, 1895.
33. Brit. J. Phot. 1873, **20**, 1.
34. E. P. 7571, 1913.
35. E. P. 1511, 1857.
36. E. P. 16040, 1915, abst. J. S. C. I. 1916, **35**, 755.
37. E. P. 18216, 1902.
38. E. P. 28415, 1907; abst. J. S. C. I. 1909, **28**, 383; Brit. J. Phot. 1909, **56**, 198.

Pifer,¹ P. Placet,² B. Pont,³ H. Rafter,⁴ G. Re,⁵ J. Rodrigues,⁶ I. Rubie and J. MacMannus,⁷ M. Sandman,⁸ Schelte & Giesecke,⁹ H. Schmidt,¹⁰ J. Schrank,¹¹ W. Schumacher,¹² W. Schupp,¹³ E. Shepherd,¹⁴ H. Silberman,¹⁵ F. Smith,¹⁶ Societe Anonyme Petit collin,¹⁷ F. Stokes and C. Hillman,¹⁸ D. Cameron-Swan,¹⁹ J. Swan,²⁰ J. Szczepanik,²¹ A. Valentin and J. Zerreichs,²² L. Villemaire,²³ E. Vogel, M. and G. Walker and J. Bonnaud,²⁴ P. Waterlow and J. Geddes,²⁵ J. Waterhouse,²⁶ R. Whittet,²⁷ R. Wigmann,²⁸ W. Wilkinson,²⁹ A. Ten-Winkel,³⁰ J. Williams,³¹ W. Woodbury,³² G. Woodiwiss,³³ and E. de Zuccato³⁴ The above embrace details of processes similar to the Stanotype, and Woodbury-type.

In the preparation of diffraction grating replicas, T. Throp

1. E. P. 359768, 1905; abst. J. S. C. I. 1906, **25**, 444
2. E. P. 2190, 1864.
3. E. P. 309, 1855.
4. E. P. 1908, 1884
5. Archiv.; abst. Brit. J. Phot. 1877, **24**, 103
6. Brit. J. Phot. 1878, **25**, 195.
7. E. P. 6087, 1894; abst. J. S. C. I. 1895, **14**, 507
8. E. P. 13238, 1909; abst. Brit. J. Phot. 1908, **55**, 778
9. D. R. P. 124552, 1900
10. E. P. 17610, 1904; abst. J. S. C. I. 1901, **23**, 998
11. Brit. J. Phot. 1871, **18**, 27.
12. E. P. 3342, 1891; abst. J. S. C. I. 1891, **10**, 573.
13. Chem. Ztg. 1912, **36**, 641; abst. C. A. 1913, **7**, 2020
14. Brit. J. Phot. 1896, **43**, 502
15. Fortschritte auf dem Gebiete der Photographie und Chemigraphischen Reproduktionsverfahren, 1907.
16. U. S. P. 734762, 1903.
17. E. P. 8557, 1908, abst. Brit. J. Phot. 1909, **56**, 125
18. E. P. 21209, 1907
19. E. P. 21018, 1902, abst. J. S. C. I. 1903, **22**, 1063.
20. E. P. 1791, 1865
21. E. P. 17065, 1908, abst. J. S. C. I. 1908, **27**, 1178
22. E. P. 18338, 1900. See also E. Vogel, E. P. 8088, 1900, abst. Brit. J. Phot. 1900, **47**, 428
23. Brit. J. Phot. 1911, **58**, 422.
24. E. P. 16476, 1886.
25. Phot. News, 1892, **36**, 243
26. Phot. News, 1881, **25**, 523, 1882, **26**, 715, 1883, **27**, 725, 1883, **27**, 773, 1884, **28**, 86, 620; 1885, **29**, 302, 411
27. Phot. Times, abst. Brit. J. Phot. 1895, **42**, 572, 601
28. E. P. 13666, 1909.
29. Brit. J. 1883, **30**, 223.
30. U. S. P. 522566, 1894.
31. Phot. News, 1898, **42**, 217
32. E. P. 2912, 1878. See also Phot. News, 1883, **27**, 582, 1884, **28**, 177; Brit. J. Phot. 1878, **25**, 182; 1883, **30**, 484
33. E. P. 5692, 1907.
34. E. P. 4145, 1883.

in 1898¹ and R. Wallace² used a solution of celluloid or pyroxylin in amyl acetate.

X-ray Screens. In Roentgen ray work and the preparation of calcium tungstate and other luminous screens, collodion has been extensively employed.³ F. Amseder,⁴ A. Edwards,⁵ M. Levy,⁶ M. Martin,⁷ W. Price,⁸ and E. Saleil⁹ have described processes.

Collodion for Solar and Astronomical Work has been in use for many years. The celestial photographic work of W. De la Rue,¹⁰ photographing the transit of Venus in 1874,¹¹ and the work of A. Common,¹² H. Krone,¹³ H. Pritchard,¹⁴ H. Russell,¹⁵ P. Secchi,¹⁶ H. Vogel,¹⁷ J. Waterhouse¹⁸ and S. Wortley,¹⁹ indicate advancement in this direction.

Collodion in Spectroscopy. In work in the infra-red of the spectrum,²⁰ spectrographs in ultra-violet light, the focussing of spectral lines,²¹ and the work of W. Hartley²² and V. Schumann²³ epitomize advancement in this direction.

The texture of negatives,²⁴ micro-structure of collodion nega-

1. Brit. J. Phot. 1905, **52**, 1031.
2. Astrophysical J. 1905, 123; abst. Brit. J. Phot. 1905, **52**, 929; 1906, **53**, 450. See also S. Strutt, Phot. News, 1873, **17**, 262, 405. Brit. J. Annual, 1907, 833. Eder's Jahr. Phot. 1905, 328. Phot. Times, 1901, 221; 1905, 239, 389. U. S. P. 705490, 817569, 839853, 898369. C. Schreiber, E. P. 24132, 1901; abst. J. S. C. I. 1902, **21**, 1469. Phot. Annual, 1892, 110.
3. Eder's Jahr. Phot. 1898, 237; 1903, **17**, 418.
4. D. R. P. 237015; abst. Wag. Jahr. 1911, **57**, II, 508.
5. E. P. 111913, 1916; abst. J. S. C. I. 1918, **37**, 75-A.
6. E. P. 10098, 1897; D. R. P. 106576, 1897; abst. Chem. Centr. 1900 **71**, 1, 698.
7. E. P. 24618, 1904.
8. U. S. P. 753310, 1904; abst. J. A. C. S. 1904, **26R**, 429.
9. F. P. 468806, 1913; abst. J. S. C. I. 1914, **33**, 986.
10. Phot. News, 1861, **5**, 436. Brit. J. Phot. 1862, **9**, 107.
11. Glaisher, Phot. News, 1874, **18**, 52⁴. W. Abney, Phot. News, 1874, **18**, 429; 1875, **19**, 154. Brit. J. Phot. 1875, **22**, 136.
12. Phot. News, 1886, **30**, 458; 1889, **33**, 10, 73.
13. Helius, abst. Phot. News, 1873, **18**, 118, 158.
14. Brit. J. Phot. 1868, **15**, 601.
15. Phot. News, 1894, **38**, 597.
16. Phot. News, 1858, **2**, 110.
17. Phot. Mitth.; abst. Phot. News, 1876, **20**, 158.
18. Phot. News, 1872, **16**, 295, 308.
19. Phot. News, 1874, **18**, 410.
20. R. Chaboseau, Chem. Ztg. 1910, **34**, 955.
21. D. v. Monckhoven, Phot. News, 1874, **18**, 296.
22. Phot. News, 1886, **30**, 182.
23. Phot. News, 1890, **34**, 361, 381.
24. J. Girard, Compt. rend. 1876, **82**, 736; abst. Phot. News, 1876, **20**, 214; 1877, **21**, 34, 441.

tives,¹ grain of silver images in the wet collodion process,² are subjects in the microscopic structure of collodion and celluloid as applied to photographic processes, the original references of which should be consulted for details.³ E. Gripon⁴ has shown that if a film of collodion is poured upon the surface of a wet, glass plate, it may be separated from the glass, after drying, in the form of a very thin, transparent pellicle which can be placed in a frame. This membrane with its polished surface, reflects light in the same way as glass, and polarizes light both by reflection and transmission. The maximum angle of polarization is $33^{\circ} 35'$ reckoned from the surface, or $55^{\circ} 25'$ normal. According to the law of Brewster, it is deduced that collodion has an index of refraction, $n = 1.51081$, which is somewhat greater than that of crown glass. He has shown that it is possible with the aid of this index, and by observing the displacement of the ranges of interference produced by a membrane of this nature, to calculate its thickness. The films experimented upon were less than 0.01 mm. in thickness, varying from 0.0081–0.0088 mm.

Through this thin collodion screen a large proportion of radiating heat may pass. Taking as the sources of heat, sometimes the flame of a moderator lamp or of a candle placed in the focus of a metallic reflector and maintained at a constant height, it was found that the membrane allowed 0.91 of the luminous heat to pass. When a blackened can of boiling water was taken as the source, the proportion of heat transmitted was not more than 0.70. If the can was maintained at a temperature of 50° , only 0.50 of the heat passed, and this amount did not sensibly decrease when the temperature of the source was 20° less. When two films of collodion were⁵ placed in the track of the heat emanating from a can heated to 100° , the amount of heat transmitted was 0.583; the first transmitted 0.70 of the heat, and the second film allowed 0.80 of the heat which traversed the first screen to pass through it.

He formed polarizers by means of collodion films which

1. F. Frary and G. Woollett, Eighth Int Cong Appl Chem 1912, **20**, 149, abst. Brit. J. Phot 1912, **59**, 879.

2. Monpillard, Phot Mitth. 1907, **44**, 514, Brit J Phot 1907, **54**, 936.

3. Brit. J. Annual, 1914, 617. Amat Phot. 1904, **39**, 390. Eder Jahr.

• Phot. 1908, **22**, 491; 1913, **27**, 390. W. Forgan, Phot News, 1902, **46**, 235.

4. Compt rend 1875, **80**, 882, abst Phot News, 1875, **19**, 209. Phot. News, 1881, **25**, 174.

served both for light and for heat. The polarizers are prepared by cementing collodion films upon tiny plates of zinc cut in the form of frames, superposing and inclining the sheets of collodion at an angle of 30° $35'$ upon the direction of the rays. They have a transparency much superior to mica, and although more fragile than mica, are also more easily prepared. If two instruments, each composed of six films, are placed to intercept the heat rays, it will be found that those crossed, in which the planes of incidence are perpendicular, only allow 0.66 part of the heat transmitted by the parallel instruments to pass through. By placing nine films before a Nicol prism, and noting the deviations of the galvanometer when the principal section of the prism is parallel or perpendicular to the plane of polarization of the film, it is found that the polarized heat composes 0.6-0.7 of the pencil transmitted.

In photo-micrography (a cacophonous word) collodion has been extensively employed, and in the siege of Paris during the Franco-Prussian war was developed to a high degree of perfection by Dagron.¹ Full instruction concerning this interesting branch of collodion technology will be found² in the disclosures of T. Barrett,³ J. Bockett,⁴ S. Bottone,⁵ J. Elsdon,⁶ Girard,⁷ H. Gunther,⁸ G. Johnson,⁹ A. Neyt,¹⁰ J. Nicol,¹¹ W. Olley,¹² A. Pringle,¹³ Pike,¹⁴ O. Rood,¹⁵ A. Sanders,¹⁶ R. Traer,¹⁷ J. Weightman,¹⁸ Wille-

1. Brit. J. Phot. 1871, **18**, 426; Phot. News, 1897, **43**, 211. See Moigno, Brit. J. Phot. 1871, **18**, 372.

2. Dagron, Brit. J. Phot. 1900, **47**, 434. See also Brit. J. Phot. 1907, **54**, 39. G. Shadbolt, Brit. J. Phot. 1859, **6**, 104. Phot. News, 1858, **2**, 4, 32. Eder's Jahr. Phot. 1909, **23**, 531. Phot. Annual, 1892, 110. J. Daucer, Brit. J. Phot. 1859, **6**, 91, 104, 118, 125, 126.

3. Phot. News, 1858, **2**, 127.

4. Brit. J. Phot. 1862, **9**, 162.

5. Phot. News, 1885, **29**, 300.

6. Phot. News, 1882, **26**, 723.

7. Bull. Soc. Franc. Phot. 1876, **22**, 161.

8. Phot. News, 1889, **33**, 18.

9. Phot. News, 1883, **27**, 109, 125.

10. Brit. J. Phot. 1862, **9**, 127.

11. Phot. News, 1858, **2**, 167.

12. E. P. 896, 1856.

13. Phot. News, 1888, **32**, 126.

14. Humphrey's J.; abst. Bull. Soc. Chim. 1864, **1**, 237.

15. Amer. J. Sci. (Sill); abst. Brit. J. Phot. 1861, **8**, 378, 531, 546; Phot. News, 1861, **5**, 530.

16. Phot. News, 1874, **18**, 170.

17. Phot. News, 1858, **2**, 104.

18. Brit. J. Phot. 1864, **11**, 147.

min,¹ and Wood,² especially in the work of the latter three.

Photoxylography, or the deposition upon wood of images, usually of collodion, less frequently spoken of as collodion wood engraving, being the employment of a photographic image to wood blocks to save the laborious work of the artist, perhaps had its inception from an English patent which E. Newton took out in 1857 for a correspondent.³ In this, the pores of the wood were first filled with zinc white or similar substance, polishing then collodionizing and exposing in the camera.

F. Grüne⁴ patented the transfer of a collodion positive to wood by means of gum or albumen, then dissolving the collodion and leaving a metallic picture which would not interfere with the engraver. Various photoxylographic processes have been disclosed by J. Contencin,⁵ G. Dawson,⁶ P. Duchochois,⁷ T. Harris,⁸ R. Hunt,⁹ J. Husnik,¹⁰ A. Nicol,¹¹ V. Pavloffski,¹² W. Rawlings,¹³ and others.¹⁴

One of the great advancements in photography has been the use of hydrazines in a gelatin or collodion emulsion, as described by W. Caldwell.¹⁵ In the presence of formyl hydrazine, or hydrazine phosphate or sulfate, it is immaterial whether the exposure is short or long, because the image may be developed in the ordinary manner. For instance, with an ordinary plate with extreme over exposure, one obtains a positive instead of a negative, i. e., a reversal of image, whereas with hydrazine present, a negative is obtained, irrespective of the time of exposure.¹⁶

1. Brit. J. Phot. 1865, **12**, 153.

2. Amer. J. Phot. abst. Phot. News, 1861, **5**, 393.

3. E. P. 1511, 1857.

4. E. P. 2022, 1869. See Brit. J. Phot. 1870, **17**, 471.

5. Phot. News, 1861, **5**, 101.

6. Brit. J. Phot. 1869, **16**, 325.

7. Phot. News, 1895, **39**, 9.

8. Practical Phot.; abst. Phot. News, 1879, **23**, 275.

9. Phot. News, 1858, **2**, 158.

10. Phot. News, 1879, **23**, 4.

11. Brit. J. Phot. 1873, **20**, 231.

12. Phot. News, 1884, **28**, 193.

13. Brit. J. Phot. 1892, **39**, 230.

14. H. Vogel, Brit. J. Phot. 1869, **16**, 343. See also Brit. J. Phot. 1865, **12**, 72; 1876, **23**, 206; 1878, **25**, 142; 1900, **47**, 326. Phot. News, 1890, **34**, 601; 1905, **49**, 302.

15. U. S. P. 956567, 1910; E. P. 1689, 1908; abst. J. S. C. I. 1909, **23**, 259; Mon. Sci. 1912, **77**, 62.

16. For the purely theoretical developmental side of this subject see W. Abney, Phot. News, 1882, **26**, 506. Brit. J. Phot. 1880, **27**, 272, 282. W. Bancroft, J. Phys. Chem. 1910, **14**, 56, 68, 71, 73. Brit. J. Phot. 1910, **57**,

- *Celluloid Cements*¹ have been extensively used in increasing adhesion of collodion preparations, and have been dealt with by J. Waterhouse.² •

*Celluloid Dishes and Measures*³ in a great variety of forms and for a multitude of uses have been used in photographic technique, and are described in the writings of F. Brown and W. Edwards,⁴ G. Brown,⁵ N. Brown,⁶ R. Burgess and E. Leigh,⁷ G. Crane,⁸ A. Edwards,⁹ B. Edwards,¹⁰ C. Gould,¹¹ A. Henderson,¹² P. Hillhouse,¹³ C. Hillman,¹⁴ G. Houghton & Son,¹⁵ Hunaeus,¹⁶ Kodak, Ltd.,¹⁷ J. Levi,¹⁸ J. Merrett,¹⁹ J. Avery,²⁰ F. Mills,²¹ H. de

630. W. Cooper and W. Nuttall, Brit J Phot 1908, **55**, 62. Frankland, Brit. J Phot 1872, **19**, 12. E. Goldberg, Brit. J. Phot. 1910, **57**, 678; 1912, **59**, 920. C. Guignet, Phot News, 1889, **33**, 450. J. Haycroft, Phot News, 1890, **34**, 704. M. Lea, Brit J Phot 1866, **13**, 60, 112. E. Lehman and P. Knoche, Zts. Reproduktionstechnik, **16**, 8, 21; abst. C. A. 1914, **8**, 2318. R. Leumann, P. P. 434625, 1911, abst. J. S. C. I 1912, **31**, 303. R. Liesegang, Brit. J. Phot 1898, **45**, 242. Luppö-Cramer, Zts. Chem Ind Koll, **3**, 33. Monpillard, Brit. J Phot. 1908, **55**, 3. H. Petschler, Brit. J Phot. 1865, **11**, 133. O. Rood, Brit. J. Phot. 1862, **9**, 190. W. Russel, Phot News, 1897, **41**, 486, 503, Brit. J. Phot 1899, **46**, 185, 200. K. Schaum and E. Schloemann, Brit J Phot 1906, **53**, 687. St George, Brit J. Phot 1884, **31**, 245. H. Thrift, Brit J. Phot 1906, **53**, 547. Trobridge, Brit J Phot. 1899, **46**, 605. E. Valenta, Chem Zig 1910, **34**, 713, 722. L. Vidal, Phot News, 1889, **33**, 99. C. Wiedemann, Compt rend 1880, **91**, 893; abst Phot News, 1881, **25**, 174.

1. Amer J Phot 1892, **13**, 84. Bull. Pharm. 1912, 220, Brit J Phot. 1907, **54**, 686. Camera, 1888-1889, **3**, 193. Jahr. Phot 1895, **9**, 459, 1902, **16**, 518, 1910, **24**, 516, 1912, **26**, 636; Phot Mitth 1903, **40**, 29, 1905, **42**, 280, 365, 1907, **44**, 337. Photography, 1900, **12**, 549, 747, 1901, **13**, 350, 1902, **14**, 621. Phot. Annual, 1895, 164. Phot. News, 1904, **48**, 494. Phot. Times, 1895, **27**, 311; 1889, **19**, 312. J. Swain, Phot Times, 1891, **21**, 635.

2. Phot News, 1890, **34**, 379.
3. Phot News, 1878, **22**, 561; 1896, **40**, 178. Phot Mitth 1894, **30**, 29, 1912, **49**, 19. Brit J Phot 1884, **31**, 95, 1899, **46**, 392.

- 4. E. P. 21505, 1896.
- 5. Brit J Phot 1895, **42**, 220, 261.
- 6. E. P. 25048, 1903. U. S. P. 721011, 744030, 1904.
- 7. E. P. 8357, 1903.
- 8. Brit. J Phot. 1912, **59**, 445. E. P. 660, 1912.
- 9. Brit. J. Phot. 1895, **42**, 220, 675.
- 10. E. P. 14074, 1893.
- 11. E. P. 24525, 1902.
- 12. Brit. J. Phot. 1899, **46**, 431.
- 13. E. P. 9515, 1904.
- 14. E. P. 1359, 1907.
- 15. Brit. J. Phot. 1900, **47**, 22.
- 16. Phot. Mitth. 1893, **29**, 29, 84.
- 17. E. P. 19631, 1902; 24246, 1904.
- 18. E. P. 17852, 1899; abst. Brit. J. Phot. Suppl. 1900, **47**, 96. Phot. News, 1898, **42**, 389.
- 19. E. P. 11700, 1908.
- 20. E. P. 1651, 1856.
- 21. E. P. 21639, 1903.

Molard,¹ A. Sanderson,² G. Sershall,³ E. Stebbing,⁴ W. Taylor,⁵ and David.⁶ These include celluloid shutters, funnels, developing trays and dishes, squeegees, measuring cups, frames, dish covers, print cutter parts, plate lifters and holders, and vignetting.

Celluloid Reliefs. In the embossing of photographs,⁷ photo-reliefs,⁸ bas-reliefs for decorative purposes,⁹ molds from photographic originals,¹⁰ and transparencies (photophane), celluloid has been widely used.¹¹

*Celluloid Focussing Screens*¹² have been described by D. Carvalho,¹³ and matt celluloid sheets instead of ground glass for focussing screens of cameras.¹⁴

For a description of the various apparatus employing collodion parts or in connection strictly with collodion photographic work, reference is made¹⁵ to the patented processes and communications of C. Anthoni,¹⁶ T. Blair,¹⁷ N. Brown,¹⁸ Comp. Gen. des Etablissements Pathe Freres Phonographie et Cinematographie,¹⁹ F. Cossitt and L. Castor,²⁰ G. Eastman,²¹ C. Hillman,²² J. Lafarge,²³ C. Lambert,²⁴ J. Lefevrier,²⁵ S. Livett,²⁶ E. Mertens,²⁷ F. Mills,²⁸

1. Bull. Soc. Franc. Phot. 1864, **10**, 344
2. E. P. 25105, 1903.
3. E. P. 10012, 1890; 3121, 1897 G. Sershall and H. Kirk, E. P. 17122, 1897
4. Brit. J. Phot. 1884, **31**, 30
5. E. P. 5198, 1905.
6. Phot. News, 1883, **27**, 822.
7. A. Hart, E. P. 5055, 1888 D. Lichtenberg-Madsen, E. P. 14814, 1898
8. T. Marceau, E. P. 20387, 1896, abst. J. S. C. I. 1896, **15**, 764, 846.
9. R. Namias, E. P. 4361, 1907.
10. F. Palmer, E. P. 18210, 1902. W. Ohse, E. P. 9763, 1901
11. W. Woodbury, E. P. 2912, 1878
12. Brit. J. Phot. 1866, **13**, 545, 1909, **56**, 210 Amer. Annual, Phot. 1892, 212. Anthony's Phot. Annual, 1894, **6**, 72. Phot. Ztg. 1909, **33**, 385. Phot. Times, 1889, **19**, 230 Photography, 1903, **15**, 42
13. U. S. P. 237240, 237247, 237248, 1881
14. Journoud, E. P. 5793, 1886; abst. Phot. News, 1887, **31**, 236.
15. Frenzel, Pap. Ztg. 1899, **24**, 903 Eder's Jahr Phot. 1894, **8**, 123
16. E. P. 3024, 1860.
17. Swiss P. 13528, 1896.
18. E. P. 25048, 1903. Reference is made to E. P. 3765, 1903.
19. E. P. 2067, 1915; abst. C. A. 1917, **11**, 2077.
20. U. S. P. 1180255, 1916; abst. C. A. 1916, **10**, 1475
21. E. P. 3530, 1887.
22. U. S. P. 920138, 1909. E. P. 1359, 1907.
23. E. P. 2598, 1862.
24. E. P. 1825, 1875.
25. E. P. 3628, 1881.
26. E. P. 25234, 1901.
27. E. P. 17199, 1904.
28. E. P. 21639, 1903.

- G. Pifer,¹ M. Reichenbach,² P. Rolier,³ Y. Schwartz,⁴ Soc. Anon. Nouvelle L'Oyonnithé and H. de Boistesselin,⁵ F. Stokes and C. Hillman,⁶ W. Walker and G. Eastman,⁷ E. Wedgwood,⁸ and A. Wilson.⁹

In connection with the development of the ramifications of the foregoing topics, attention should be drawn to the improvements, both chemical and mechanical, which have been made by T. Able,¹⁰ P. de Fontainemoreau,¹¹ H. Avet,¹² L. Backeland,¹³ A. Balconi,¹⁴ W. Barker,¹⁵ T. Barrett,¹⁶ A. Beaumont,¹⁷ R. Biedermann,¹⁸ F. Blaisdell,¹⁹ G. Bradshaw,²⁰ W. Brookes,²¹ H. Carbonnelle,²² D. Carnegie,²³ D. Carvalho,²⁴ J. Cheetham,²⁵ Chem. Fabrik. Actien vorm. F. Schering,²⁶ L. Cornides,²⁷ H. Curtis,²⁸ J. Fallowfield,²⁹ E. Dunmore,³⁰ W. England,³¹ O. v. Eversbusch,³² R. Faulkner,³³ L. Favre,³⁴ M. Frank,³⁵ O. Fulton and W. Gillard,³⁶ J. and B.

1. E. P. 28756, 1907; abst. J. S. C. I. 1908, **27**, 1220.
2. U. S. P. 619617, 1899.
3. E. P. 7766, 1905; abst. J. S. C. I. 1906, **25**, 493.
4. Phot. Ztg. 1898, **22**, 20.
5. F. P. 420983, 1910; abst. Kunst. 1911, **1**, 155.
6. E. P. 21209, 1907.
7. U. S. P. 370111, 1887.
8. E. P. 13753, 1910; abst. J. S. C. I. 1911, **30**, 888.
9. E. P. 1712, 1862.
10. E. P. 12629, 1909.
11. E. P. 2465, 1864.
12. E. P. 2110, 1865.
13. D. R. P. 43521, 1887. See Jahr Chem. 1892, **45**, 2940.
14. F. P. 466996, 1914; abst. Ann. Rep. Soc. Chem. Ind. 1916, **1**, 302.
15. E. P. 15249, 1907.
16. Phot. News, 1858, **1**, 203.
17. E. P. 5109, 1906; abst. Brit. J. Phot. 1906, **53**, 993.
18. E. P. 2356, 1907; abst. J. S. C. I. 1907, **26**, 1005.
19. E. P. 639, 1905.
20. E. P. 17967, 1891; abst. J. S. C. I. 1891, **10**, 971; 1892, **11**, 730.
21. Brit. J. Phot. 1880, **27**, 210.
22. Brit. J. Phot. 1908, **55**, 268.
23. Brit. J. Phot. 1907, **54**, 913.
24. U. S. P. 237247, 1881.
25. E. P. 2871, 1850.
26. E. P. 2036, 1894; abst. J. S. C. I. 1894, **13**, 194, 422; 1894, **14**, 65, 386.
27. E. P. 2112, 1855.
28. Astronomical Soc. of the Pacific, 1911, **23**; abst. Brit. J. Phot. 1911, **58**, 681.
29. Brit. J. Phot. 1909, **56**, 980, 1002.
30. Brit. J. Phot. 1883, **30**, 30.
31. Phot. News, 1890, **34**, 364.
32. Archiv. f. Ophthalmologie, 509.
33. E. P. 1642, 1872; abst. Brit. J. Phot. 1873, **20**, 171.
34. E. P. 1569, 1880.
35. Atelier Phot. **17**, 133; abst. C. A. 1911, **5**, 252.
36. E. P. 6018, 1904; abst. J. S. C. I. 1905, **24**, 290.

Galay,¹ Grenier Art Co.,² J. Griffin & Sons, Ltd., and J. Thompson,³ G. and D. Hay,⁴ M. Herve,⁵ P. Hewitt,⁶ H. Kuntzen,⁷ M. Holzberg,⁸ T. Hooman and J. Maliszewski,⁹ E. Hoskins,¹⁰ G. Itasse,¹¹ A. Jarman,¹² C. Kirby,¹³ J. Lambert,¹⁴ C. Langlois,¹⁵ E. Laporte,¹⁶ S. Lees,¹⁷ R. Leumann,¹⁸ A. Lombardi,¹⁹ O. Lortzing,²⁰ A. Mallock,²¹ P. Moss,²² J. Obernetter,²³ Pefer,²⁴ J. Pein,²⁵ E. Pettit,²⁶ Photochemischefabrik R. Risse,²⁷ G. Pluss,²⁸ B. Pont,²⁹ E. Potter,³⁰ P. Reid and J. Eastwood,³¹ J. Reynolds,³² H. Rheinlander,³³ J. Robinson,³⁴ Rotophot Ges. f. Photographische Industrie,³⁵ J. Schnauss,³⁶ J. Schumacher and G. Stade,³⁷ G. Sealey and J. Lee,³⁸ H. Smith,³⁹ Societe H. Merville et Cie,⁴⁰ E. Stebbing,⁴¹ E. Stockis,⁴²

1. E. P. 1715, 1909; abst. J. S. C. I. 1909, **28**, 1163.
2. E. P. 13317, 1900; abst. J. S. C. I. 1900, **19**, 807, 1068.
3. E. P. 27486, 1910; abst. Brit. J. Phot. 1911, **58**, 859.
4. E. P. 2808, 1855.
5. Brit. J. Phot. 1898, **48**, 487.
6. E. P. 16271, 1911.
7. E. P. 1286, 1905.
8. Phot. News, 1895, **39**, 361.
9. E. P. 1089, 1861.
10. Phot. News, 1873, **17**, 17.
11. D. R. P. 106334, 1897; abst. Chem Centr 1900, **71**, 1, 698.
12. Phot. News, 1904, **48**, 338.
13. E. P. 121499.
14. E. P. 13475, 1905.
15. E. P. 2254, 1856.
16. Brit. J. Phot. 1909, **56**, 595.
17. E. P. 22244, 1907; abst. Brit. J. Phot. 1908, **55**, 816. See also E. P. 1367, 1877; 24750, 1898, 25942, 28793, 1902.
18. F. P. 434625, 1911; abst. J. S. C. I. 1912, **31**, 303.
19. E. P. 3196, 1878.
20. D. R. P. 109839; abst. Jahr Chem 1900, **53**, 847.
21. Brit. J. Phot. 1899, **46**, 244.
22. E. P. 2274, 1910.
23. Phot. News, 1874, **18**, 255.
24. F. P. 359768, 1905; abst. C. A. 1907, **1**, 1648.
25. E. P. 2393, 1859.
26. E. P. 72, 1865.
27. F. P. 363086, 1906; abst. J. S. C. I. 1906, **25**, 867.
28. F. P. 456925, 1913; abst. Chem Ztg. Rep. 1913, **37**, 423.
29. E. P. 309, 1855.
30. E. P. 14171, 1888.
31. E. P. 1849, 1882.
32. E. P. 1112, 1880; abst. Wag. Jahr 1881, **27**, 136, Chem. Ind. 1881, **3**, 175.
33. Brit. J. Phot. 1911, **58**, 241.
34. Brit. J. Phot. 1896, **46**, 179.
35. E. P. 13793, 1908.
36. Phot. Woch.; abst. Phot. News, 1878, **22**, 268.
37. E. P. 748, 1879.
38. U. S. P. 27572, 1880.
39. Ilford Photo. Scraps; abst. Phot. News, 1904, **48**, 169.
40. E. P. 28793, 1902.

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 - 41. Brit. J. Phot. 1882, **29**, 215.
 - 42. Brit. J. Phot. 1912, **59**, 195.
 - 1. E. P. 21209, 1907; abst. Brit. J. Phot. 1908, **55**, 220.
 - 2. Brit. J. Phot. 1871, **18**, 175.
 - 3. F. P. 434791, 1910; abst. J. S. C. I. 1912, **31**, 303.
 - 4. U. S. P. 786536, 1905; E. P. 17738, 1899; abst. J. S. C. I. 1900, **19**, 689; 1905, **24**, 513.
 - 5. Brit. J. Phot. 1899, **46**, 822.
 - 6. E. P. 775, 1882; abst. Brit. J. Phot. 1882, **29**, 631.
 - 7. Freie Phot. Ztg.; abst. Brit. J. Phot. 1907, **54**, 42.
 - 8. Brit. J. Phot. 1880, **27**, 256. See also A. Weiss, D. R. P. 140529, 1901.
 - 9. E. P. 446, 1864.
 - 10. E. P. 12309, 1889; abst. Phot. News, 1890, **34**, 582.
 - 11. E. P. 13191, 1890.
 - 12. Brit. J. Phot. 1882, **29**, 78.
 - 13. Brit. J. Phot. 1882, **29**, 248.
 - 14. U. S. P. 17651, 1857. For nitrocellulose filters see G. Brown, Brit. J. Phot. 1895, **42**, 264.
 - 15. Belg. P. 61821, 1883.
 - 16. Cosmos, **12**, 320; abst. Poly. Centr. 1858, **24**, 675.
 - 17. Bull. Soc. Franc. Phot.; abst. Bull. Soc. Chim. 1864, **1**, 238.
 - 18. Bull. Soc. Chim. 1864, **1**, 155.
 - 19. Pharm. J. Trans., Dec. 15, 1889; abst. Amer. J. Pharm. 1889, **61**, 45, 99, 155, 199.
 - 20. E. P. 14039, 14743, 21099, 1909; F. P. 410986, 416554, 1910; abst. J. S. C. I. 1910, **29**, 517, 720, 901, 1410.
 - 21. F. P. 105161, 1874; Addn. dated Oct. 21, 1874, Mar. 30, May 4, Aug. 17, 1875; May 6, 1876.
 - 22. Chem. Ind. 1893, **16**, 443; 1910, **33**, 449, 486, abst. Chem. Tech. Rep. 1893, **32**, II, 232.
 - 23. F. P. 326468, 1902; abst. J. S. C. I. 1903, **22**, 820, 1256; 1904, **23**, 337; Mon. Sci. 1905, **63**, 88; Chem. Zts. 1903, **2**, 442.
 - 24. D. R. P. 25171; abst. Wag. Jahr. 1883, **29**, 1134; Bied. Tech. Chem. Jahr. 1883, **6**, 475.
 - 25. D. R. P. 227130, 223819; abst. J. S. C. I. 1910, **29**, 977, 1410, Wag. Jahr. 1910, **56**, II, 539.
 - 26. D. R. P. 223922, 226598, 231599; abst. C. A. 1911, **5**, 1564; Chem. Ztg. Rep. 1910, **34**, 368; Chem. Zentr. 1910, **61**, 1351; 1911, **82**, I, 771; Jahr. Chem. 1910, **63**, I, 208.
 - 27. F. P. 314607, 1901; abst. Mon. Sci. 1903, **59**, 61.
 - 28. E. P. 856, 1888; abst. Phot. News, 1888, **32**, 42.
 - 29. Belg. P. 171371, 1903.
 - 30. Bull. Soc. Franc. Phot. 1882, **28**, 319.
 - 31. U. S. P. 141351, 1873.

Jeanrenaud,¹ W. Kelly,² R. Krayn,³ D. Lance,⁴ R. Leumann,⁵ H. Lüttke,⁶ Marion,⁷ Montruil,⁸ A. Muller-Jacobs,⁹ H. Palmer,¹⁰ Petschler,¹¹ Piard,¹² E. Pin,¹³ Portass, Portass and Portass,¹⁴ J. Rieder,¹⁵ E. Rouxville,¹⁶ E. Saunders,¹⁷ Schnauss,¹⁸ Y. Schwartz,¹⁹ J. Smith,²⁰ W. Stanley,²¹ T. Sutton,²² Swan,²³ Teissiere and Jacquemet,²⁴ Truemann-Wood,²⁵ E. Valenta,²⁶ and H. Vogel.²⁷

Cellulose Nitrate Smokeless Powders. *Section Ten.* The historical development of this subject is comprehended under the following headings:

1. *Development of the Nitrocelluloses, Historically* (p. 2922)
2. *Classification of Nitrocellulose Powders* (p. 2942).
3. *Nitrocellulose-nitroglycerol Powders* (2948), cordite (2949)
4. *Smokeless Powders by their Names* (2968).
5. *Manufacturing Processes* (2976).

1. Mon. Sci. 1863, **5**, 396
2. Belg. P. 191747, 1906. W. Kelly and J. Bentham, Swiss P. 35454, 1905.
3. D. R. P. 167232, 167613, abst. Wag. Jahr. 1906, **52**, 11, 487
4. Belg. P. 234301, 1911.
5. F. P. 434625, 1911; abst. J. S. C. I. 1912, **31**, 303
6. D. R. P. 132421, 135318, abst. Chem. Ztg. 1902, **26**, 1046, Jah. Chem. 1902, **55**, I, 111.
7. Rep. Chim. Appl. 1862, **4**, 325.
8. Mon. Phot.; abst. Bull. Soc. Chim. 1864, **1**, 154
9. U. S. P. 474850, 1892; abst. J. A. C. S. 1892, **14**, 141.
10. E. P. 8761, 1910; F. P. 431991, 1911, abst. J. S. C. I. 1911, **30**, 1470
11. Dingt. Poly. 1860, **158**, 318, abst. Poly. Centr. 1861, **27**, 213
12. Mon. Sci. 1864, **6**, 422
13. E. P. 102066, 1916; U. S. P. 1184772, 1916; abst. J. S. C. I. 1916, **35**, 755, 1273
14. E. P. Appl. 86389, 1919, abst. J. S. C. I. 1919, **38**, 271-A
15. Swiss P. 47793, 1909
16. E. P. 17773, 1906, 13023, 1907, abst. J. S. C. I. 1907, **26**, 1207.
17. Wilson Phot. Mosaics, 1882, 80.
18. Bull. Belg. Phot.; abst. Rep. Chim. App. 1863, **5**, 324. Mon. Phot., abst. Bull. Soc. Chim. 1864, **2**, 400.
19. U. S. P. 710019, 1902, E. P. 9993, 1902; F. P. 320451, 1902; abst. J. S. C. I. 1902, **21**, 44, 1393; 1903, **22**, 440
20. E. P. 5154, 1910; F. P. 413222, abst. J. S. C. I. 1910, **29**, 1135; 1911, **30**, 447; Mon. Sci. 1912, **77**, 13.
21. E. P. 259, 1888; abst. Phot. News, 1888, **32**, 41
22. Phot. Notes, 1854, **9**, No. 191, 72; abst. Bull. Soc. Chim. 1864, **2**, 79; Mon. Sci. 1863, **5**, 741; Phot. News, 1863, June 5th, Rep. Chim. Appl. 1863, **5**, 275.
23. U. S. P. 61368, 1867.
24. Mon. Phot.; abst. Bull. Soc. Chim. 1864, **1**, 80
25. Bull. Soc. Franc. Phot. 1882, **28**, 171.
26. Chem. Ztg. 1909, **33**, 933, 942, 1911, **35**, 941, abst. C. A. 1911, **5**, 3543
27. D. R. P. 12416, 13726, abst. Wag. Jahr. 1880, **26**, 903

6. *Nitrocellulose in Manufacture of Cartridges, Detonators, Primers and Percussion Caps* (2980).

7. *Physical Constants of Smokeless Powders* (2983-2987).

Development of the Cellulose Nitrates in the War-like Arts.

In considering the historical development of nitrocellulose from various angles (see pp. 1567-1639) the early endeavors in the fields of military application have been briefly touched upon, while the purely commercial exploitation of nitrocotton for technical and peaceful uses has been epitomized under other topical headings elsewhere in this Chapter. The detailed history of the development of modern smokeless powder has never been recorded—at least in readily accessible form. Only the more important points are intended to be touched upon in this skeleton résumé, the details being reserved for Volume VII in this series dealing specifically with the subject.¹ All smokeless powders that have been manufactured up to the present time have possessed one important common characteristic, namely, all consist primarily of some form of nitrocellulose, either alone or compounded with inorganic bodies or organic compounds high in available oxygen.

It has previously been pointed out (pp. 1574-1675) that the early attempts of Schönbein, v. Lenk, and others, to make a satisfactory smokeless powder from guncotton were unsuccessful because it was erratic and much too violent in its effects, the nitrocotton being in a state of fine, loose fiber interspersed with air spaces, the explosion traversed the mass almost instantaneously. On the other hand, black powder, being a homogeneous mechanical mixture, the explosion is initiated at the periphery of the individual grains or granules, at the points where the particles of saltpeter are in contact with particles of sulfur and charcoal,

1. For general articles dealing with smokeless powders consult, O. Guttman, Zts. ang. Chem. 1889, **2**, 667; Jahr. Chem. 1890, **43**, 2678. H. Maxim, Sci. Amer. Suppl. **32**, 13114; Chem. Ind. 1896, **16**, 495; J. C. S. 1897, **71**, 495; J. Frankl. Inst. 1898, **146**, 375; Wag. Jahr. 1898, **44**, 379; New York American, Nov. 1, 1914. W. Williams, J. Frankl. Inst. 1899, **147**, 197. Wilda, Verh. Gewerbebl. 1902, 268; Wag. Jahr. 1902, **48**, II, 367. W. Both, Cassier's Ill. Mag. 1906, **30**, 291. Anon. Arms and Explo. 1906, **14**, 130. A. Klock, Sci. Amer. 1908, **65**, 68. D. Willey, Sci. Amer. 1909, **67**, 195. H. Maxim, Zts. Schiess. Spreng. 1911, **6**, 391. C. Junken, Sci. Amer. Suppl. 1912, **74**, 140. B. Koch, Zts. Schiess. Spreng. 1913, **8**, 196; abst. C. A. 1913, **7**, 2685. E. Pellen, Revista Artilharia, July, Aug., Sept. 1915. S. Young, Nature, 1919, **103**, 414; abst. C. A. 1919, **13**, 2596. G. Bethuys, Cosmos, 1888, **11**, 324.

and consequently the time of explosion is comparatively long.

The transition period of change from black powder to nitro-cellulose propellants has been long and tortuous, and beset with difficulties both chemical and psychological, and it has required years to change the *idea* of employing powerful explosives as interior charges for projectiles to a *reality*. It appears to be human nature to exhibit an antipathy towards the adoption of anything new, and when this conservatism is aggravated by the fact that substantial finance is involved in the older industry which the new idea or material is designed to supplant, it is readily seen that the (then) fanciful prediction of Schonbein that gun-cotton would eventually supplant black powder in military and naval uses, was very backward in fruition.

The development of smokeless powders in France,¹ Germany,²

1. For articles on French smokeless powders, their quality, imperfections, explosions on board of war ships, etc., see Anon., *Arms and Explo* 1897, **5**, 89; 1898, **6**, 52; 1899, **7**, 52. 1912, **20**, 20. Prof. Notes, U. S. Nav. Inst. **38**, 1115; abst. C. A. 1912, **6**, 3522. Prof. Notes, U. S. Nav. Inst. **39**, 1764; abst. C. A. 1914, **8**, 1347. *Cosmos*, 1899, **41**, 801. *Rev. d'Artill.* 1890, **36**, 566. *Compt. rend. seances conseil d'hygiene publique*, 1919, No. 11; abst. C. A. 1919, **13**, 2448. *Engineering*, **92**, 432, 463; abst. C. A. 1911, **5**, 3011. *Zts. Schiess Spreng* 1911, **6**, 438; 1912, **7**, 480; 1914, **9**, 247. C. Chabaud-Arnault, *Cosmos*, 1891, **18**, 300, 327; **19**, 270. J. Delpech, *Tech. nique moderne*, 1912, 99; abst. *Zts. Schiess Spreng*, 1912, **7**, 478, abst. C. A. 1913, **7**, 703. R. Earle, *Proc. U. S. Nav. Inst.* 1913, **39**, 398; abst. C. A. 1913, **7**, 1974. D. Florentin, *Zts. Schiess Spreng*, 1913, **8**, 6, 30; abst. J. S. C. I. 1913, **32**, 162. C. Girard and P. Iooss, *Mon. Sci.* 1913, **78**, 677. H. Hessen, *Zts. Schiess Spreng* 1911, **6**, 296; abst. C. A. 1911, **5**, 3731. P. Lambert, *Rev. chim. ind.* 1913, **24**, 29, abst. C. A. 1913, **7**, 1974. E. Neumann, *Zts. Schiess Spreng*, 1910, **5**, 449, 472, 1911, **6**, 18; abst. J. S. C. I. 1911, **30**, 50. "P. N." *Proc. U. S. Nav. Inst.* **38**, 789; abst. C. A. 1912, **6**, 2531. Sebrum, *Techn. Bl* 1881, **12**, 215. L. Serve, *Cosmos*, 1909, **60**, 339. G. Vie, *Rev. prod. chim.* 1918, **21**, 273; abst. C. A. 1919, **13**, 516. J. Verne de Corneillan, E. P. 852, 1862, proposed to nitrate silk waste. See *also* *Mem. poud. salp.* 1890-1900, **10**, 17, abst. *Zts. ang. Chem.* 1900, **13**, 965; *Wag. Jahr.* 1900, **46**, 1, 409.

2. See N. Erfind. *Erfind.* 1889, **16**, 554. E. de Vrijs, *Chem. Ztg.* 1908, **32**, 765; abst. *Chem. Zentr* 1908, **79**, 11, 1139. A. Voigt, *Zts. Schiess Spreng*, 1914, **9**, 264. J. Garcon, *Cosmos*, 1912, **66**, 217. C. Zahn, *Zts. ang. Chem.* 1914, **27**, 1, 257, abst. C. A. 1914, **8**, 2482. G. Buchner, *Zts. Ver. deut. Ing.* 1915, **59**, 469, 489, 511; abst. C. A. 1915, **9**, 3360. D. Poële, *Daily Con. and Trade Repts.* 1914, **149**, June 26, 1986; abst. C. A. 1914, **8**, 2948. See also *Zts. Schiess Spreng* 1914, **9**, 101, 123, 146, 161. *Ziegler*, *Zts. Schiess Spreng*, 1913, **8**, 295; abst. C. A. 1913, **7**, 3063. *Rev'd. Artill.* 1886, **30**, 530. *Riv. Art.* 1887, **2**, 276. In this connection attention is directed to the German patents on coating nitrocellulose explosives: D. R. P. 690, 23808, 26014; explosives comprizing nitrocellulose or other cellulose esters, or other nitrocarbohydrates, mixed with nitroglycerol or other nitrogen carriers or the like: D. R. P. 3867, 27969, 31786, 39388, 48265, 48933, 51755, 56786, 62159, 130523, 174930, 200293, 201215, 201306, 205762, 210934; explosives comprizing nitrocellulose or other cellulose esters or other nitrocarbo-

Italy,¹ Russia,² Spain,³ Roumania,⁴ Austria,⁵ Japan,⁶ Belgium,⁷ Mexico,⁸ Greece,⁹ Norway,¹⁰ Canada¹¹ and Switzerland,¹² is indicated in the data below appended. The initial impetus in all countries seems to have dated either from the first experiments with smokeless powder, or with the development of the small bore, high power, small arm rifle, or both. The key to this development was indicated by Braconnot, furnished by Schönbein and Boett-

hydrates, without the addition of other important components D. R. P. 38363, 45857, 54435, 54818, 114500, 120201, 127068, 135102, 141314, 166420, 174347, 177032, 192588, 214020, 217929, 226422; gelatinizing nitrocellulose, D. R. P. 2660, 4829, 18950, 42452, 51471, 53296, 55650, 56785, 57399, 57427, 71837, 74070, 83095, 88205, 93228, 93351, 95390, 97690, 99875, 106057, 110289, 117349, 125100, 127143, 144846, 175399, 179634, 180724, 187813, 189009, 193557, 194874, 195486, 198703.

1. E. Molinari and F. Quartieri, Zts. Schiess Spreng 1913, **8**, 478, abst. C. A. 1914, **8**, 1012. B. Oddo, Ann. chim. appl. 1919, **11**, 165; abst. C. A. 1919, **13**, 3011. D. Vitali, Giorn. farm. chim. **64**, 385; abst. Chem. Zentr. 1916, **87**, I, 1103, C. A. 1917, **11**, 3434.

2. Anon. Engng. **63**, 180. A. Saposchinnikoff, Zts. Schiess. Spreng. 1914, **9**, 187, 217; abst. J. S. C. I. 1914, **33**, 668. Cf. La Nature, 1905, II, 398.

3. See Zts. Schiess. Spreng. 1908, **3**, 154, 248, 283; 1910, **5**, 161, 188, 416. Mem. de Artilleria, 1908, Feb., Apr.; 1909, July, Sept., Oct., Nov.

4. See J. de La Llave, Mem. de artilleria (Madrid), Sept. 1912, abst. Zts. Schiess. Spreng. 1913, **8**, 98.

5. See Chem. News, 1869, **19**, 108. Les Mondes, 1863, **1**, 429. For information on explosives, including smokeless powders consult the following Austrian patents on explosives: 812, 1365, 1450, 2788, 3677, 4436, 4549, 4836, 6651, 6652, 7074, 7077, 8487, 8490, 8798, 9374, 9384, 9483, 10001, 10004, 10531, 10544, 10786, 11186, 11648, 11664, 11876, 12716, 12176, 13100, 14060, 14064, 14065, 14367, 14889, 15235, 15491, 15782, 16176, 16505, 16814, 17243, 17459, 17370, 18740, 18747, 18861, 18881, 18983, 19954, 19063, 20004, 21652, 21654, 21655, 23370, 23382, 25351, 25504, 26785, 26851, 26855, 26970, 27312, 29082, 30943, 30964, 30967, 31177, 31951, 32158, 31962, 32614, 33082, 34267, 34271, 35081, 35085, 35120, 35254, 35593, 35606, 35593, 37331, 37549, 39579, 39581, 39582, 39590, 40471, 40472, 40619, 40627, 40768, 40770, 41165, 41887, 41889, 41890, 41940, 43016, 43017, 43667, 43921, 43928, 44447, 45691, 43715, 47729, 48817, 51897, 52836, 55566, 55567, 55570, 56641, 56641, 56642, 57319, 58860, 58870, 59993, 59994, 60263, 60602, 60852, 60855, 62736, 64976.

6. A. Saposchinnikoff, Zts. Schiess. Spreng 1906, **1**, 69, abst. Chem. Centr. 1906, **77**, I, 1196. A. Eisenberg, J. U. G. Artill. 1908, **30**, 59, 186, abst. C. A. 1909, **3**, 248.

7. For commercial designation and classes of explosives as officially recognized in Belgium, see Zts. Schiess. Spreng. 1907, **2**, 14.

8. Cf. U. S. Cons. Rep. 1902, Jan. 18, abst. J. S. C. I. 1902, **21**, 203.

9. A. Logothetis, Zts. Schiess. Spreng. 1915, **10**, 52, abst. C. A. 1915, **9**, 1845.

10. W. Hendrick, Daily Con. and Trade Rep. June 26, 1914, No. 149, p. 1902.

11. J. Donald, Can. Chem. J. 1919, **2**, 523, abst. C. A. 1919, **13**, 2125.

12. In this connection reference is made to the following Swiss patents on explosives: 40190, 40467, 40468, 40469, 41274, 41369, 41370, 42736, 44198, 44372, 45324, 48097, 48356, 48922, 50077, 50227, 51814, 53255, 54430, 54331, 54509, 55940, 57058, 57774, 58685, 59167, 62140, 62589, 62590, 63133, 63134, 65926.

ger, carried further toward a practicality by v. Lenk, stabilized by Abel, and further perfected in 1888 by A. Nobel with the introduction of Cordite (which see). The French appear to have been the first to introduce new high power propellants into their service, using a BN powder composed of nitrocellulose and barium nitrate or possibly other ingredients, inasmuch as their early efforts were shrouded in much mystery and accompanied by several changes due to unexpected difficulties experienced with their early powders, of this type. These powders were first used in the Lebel small arm, and were not by any means either smokeless or otherwise ideal. Concurrently v. Lenk was endeavoring to use guncotton alone as a propellant by braiding it into cords or ropes, and winding these tightly on a wooden core, and while it must be admitted some success attended these efforts, and while Germany did serious work in developing this idea, it was inevitable that such a scheme was doomed to failure due to the not infrequent occurrence of erratic burning of an explosive in such finely divided form.

Many devices were proposed, some patented, and still fewer adopted, all having the common object of slowing the combustibility and speed of burning of guncotton in order to increase its suitability as a propellant. The theory of granulation was well known, and had been applied for many years in connection with black powders, as witnessed by the spherohexagonal grains of black powder, the varying sized irregular grains and the perforated coca, or brown powder.

To go back a step historically, efforts to force guncotton to burn progressively passed through many indistinguishable phases before a colloidal powder was finally evolved. In England, efforts were made to press guncotton into hard pellets with a matrix of India rubber. The use of small compressed cubes surrounded with wax or paraffin was also advocated. Simultaneously the Italians were struggling along the same lines with their Fossano powder, in which guncotton was distributed through a less explosive substance used as a matrix.

In the development of nitrocellulose propellants in Great Britain,¹ the initiative was undoubtedly given when Schonbein

1. In this connection see *Arms and Explo.* 1899, **7**, 105. D. Grant, *Arms and Explo.* 1896, **5**, 19. O. Guttman, *Dingl. Poly.* 1883, **249**, 455.

came to England to seek financial backing for his ideas and dis-
 509; Wag. Jahr. 1883, **29**, 393; Chem. Tech. Rep. 1890, **29**, I, 222; J. S. C. I.
 1894, **13**, 575; Zts. ang. Chem. 1898, **11**, 233; Dingl. Poly. 1899, **304**, 37;
 Jahr. Chem. 1898, **51**, 1064; Wag. Jahr. 1899, **45**, I, 417; J. Roy. Soc. Arts,
57, 113, 125. C. Hake, J. S. C. I. 1905, **24**, 915. See 27th Ann. Rep. H.
 M. Insp. Expl. 1902; abst. J. S. C. I. 1903, **22**, 881; 36th Rep.; abst. C. A.
 1912, **6**, 2531; 39th Rep.; abst. C. A. 1915, **9**, 2980; 40th Rep.; abst. C. A.
 1916, **10**, 2299. A. Cooper-Key, Spl. Rep. H. M. Insp. Expl., No. 199;
 abst. C. A. 1912, **6**, 804; see also J. S. C. I. 1911, **30**, 1334. Rep. Chief Insp.
 Expl. Western Australia; abst. J. S. C. I. 1909, **28**, 855; C. A. 1909, **3**, 2504.
 Rept. Chief Insp. of Expl. State of Victoria, abst. J. S. C. I. 1909, **28**, 1168.
 F. Jones, Arms and Explo. 1905, **13**, 88. V. Lewes, Arms and Explo. 1895,
3, 59. G. MacDonald, Zts. Schiess. Spreng. 1911, **6**, 374; Nature, 1915,
95, 508; abst. C. A. 1915, **9**, 2592. Moulton, Chem. Trade J. 1919, **64**, 523;
 abst. C. A. 1919, **13**, 2127. W. McNab, Nature, **93**, 518; abst. C. A. 1914,
8, 3304. K. Quinan, Chem. Trade J. 1919, **64**, 115, 139, 161; abst. C. A.
 1919, **13**, 1017. J. Young, J. Roy. Soc. Arts, **69**, 706, 719, 733; abst. C. A.
 1919, **13**, 262. Anon., Berg. Ztg. **43**, 161. Arms and Explo. 1898, **6**, 178,
 Chem. Ind. 1914, **37**, 510; abst. C. A. 1915, **9**, 380. Arms and Explo. 1905,
13, 29. Chem. Trade J. Oct. 3, 1914; abst. J. S. C. I. 1914, **33**, 986; C. A.
 1915, **9**, 152. The development of the explosives industry in England is
 reflected in the following English patents covering a fifty-year period: E. P.
 562, 2377, 2601, 3206, 1861; 139, 320, 1084, 1090, 1796, 1798, 2072, 1862,
 881, 949, 1062, 1028, 2359, 2555, 1863. 292, 337, 900, 1813, 2594, 2759,
 1864. 402, 1102, 1636, 1679, 1939, 2266, 2488, 2906, 3206, 1865. 595,
 845, 953, 1341, 1956, 2739, 3293, 3301, 1866. 1345, 1408, 2431, 2837, 3127,
 3469, 3652, 1867. 70, 1210, 1375, 1736, 2542, 2865, 3115, 3408, 1868. 442,
 886, 1193, 1800, 2166, 2500, 2747, 1869. 2867, 1870. 311, 1326, 1939,
 2283, 2430, 2454, 2642, 1871. 656, 752, 1509, 1885, 2693, 2766, 1872. 360,
 926, 1064, 1570, 1830, 2984, 3194, 3273, 3731, 4148, 1873. 961, 1566, 2062,
 2641, 3612, 3781, 3934, 1874. 291, 1397, 1739, 2459, 3088, 4155, 4179, 1875.
 2742, 3056, 4075, 4568, 4806, 4949, 5000, 1876. 198, 2832, 3289, 3294, 4732,
 1877. 1563, 2517, 3119, 3954, 1878. 1090, 2266, 2399, 2536, 3947, 4394,
 5013, 1879. 163, 447, 810, 1287, 2178, 2239, 2242, 2775, 3846, 4200, 4230,
 4643, 4943, 1880. 800, 801, 2226, 2302, 2488, 3923, 4544, 5584, 5596, 1881.
 567, 619, 981, 1461, 1969, 2407, 2836, 2895, 3055, 4846, 5986, 6015, 1882.
 254, 1767, 1883, 2139, 2428, 4043, 5624, 5625, 1883. 1024, 2143, 3981,
 5382, 6514, 6515, 6548, 9096, 10986, 11808, 12292, 13475, 13476, 13522,
 14140, 14361, 14379, 14914, 15546, 15647, 16314, 1884. 368, 552, 1868,
 2139, 5252, 6926, 8951, 10825, 11432, 12778, 12837, 13581, 13582, 13690,
 14052, 14412, 15089, 15129, 15528, 15694, 1885. 758, 1955, 3578, 3593,
 5330, 5331, 6258, 6604, 9166, 11140, 12532, 14623, 14803, 16595, 16656,
 1886. 448, 783, 2318, 2679, 4713, 5899, 6042, 7608, 9209, 10655, 10667,
 10821, 11658, 12424, 12743, 15532, 16116, 16783, 16919, 16920, 17167, 17506,
 1887. 370, 1469, 1471, 1591, 3759, 4310, 5949, 6560, 7497, 9164, 9799, 10722,
 11548, 11751, 13308, 13360, 13656, 13789, 14027, 16213, 16997, 17212, 17456,
 17631, 18241, 18362, 18663, 1888. 1115, 1988, 2078, 4477, 4479, 5031, 5503,
 5614, 6399, 8718, 9361, 9433, 10312, 10376, 11102, 11664, 11665, 12249, 12307,
 12338, 12427, 13480, 13763, 16138, 16142, 18727, 19935, 20104, 1889. 2547,
 3852, 4243, 5209, 7301, 7596, 8481, 8811, 11018, 14625, 15726, 16189, 18472,
 18519, 1890. 298, 365, 5027, 5821, 5843, 6128, 6129, 7256, 11326, 11326A,
 11383, 11713, 13038, 13507, 19068, 19267, 20448, 1891. 6258, 6448, 7238,
 7978, 9359, 12415, 12744, 12940, 16567, 20880, 22023, 22739, 23105, 23377,
 1892. 118, 580, 11502, 11645, 14091, 15084, 15566, 15865, 15866, 15867,
 16609, 17308, 19931, 20066, 20327, 20467, 22384, 23416, 23417, 23579, 23773,
 24425, 1893. 1074, 1982, 2499, 3024, 4626, 4795, 4796, 4797, 7038, 9798,
 11458, 12064, 13506, 15887, 18496, 18682, 18921, 19299, 19684, 20281, 22566,
 23007, 23260, 24235, 24898, 25327, 1894. 1193, 4769, 6271, 6289, 6327,

coveries, and a patent was granted to him through his friend, J. Taylor (see p. 1579). Von Lenk also explained before the British Association for the Advancement of Science the salient points of his nitration process, which was patented in both England and the United States, and the Commission appointed to investigate his claim and the state of the art in general, coupled with the researches on stability and pulping of nitrocotton by F. Abel, early placed England in the front rank in progress and development. The nitrolignin sporting powder evolved by Captain E. Schultze (see p. 1809) was one of the earliest and most successful of any of the powders of the non-colloidal type, a success which was not ephemeral, as witnessed by the fact that the powder with unimportant modifications, is produced

7231, 8569, 11283, 11424, 12325, 12768, 14775, 15834, 16311, 16790, 19667, 22898, 23242, 23443, 24847, 1895. 949, 4500, 4714, 6431, 6555, 6937, 10403, 11842, 13269, 13270, 13746, 13922, 15022, 15351, 16858, 17204, 17307, 18034, 18078, 20069, 20895, 22120, 22162, 22540, 23508, 25704, 25711, 26819, 27197, 28220, 28889, 29598, 1896. 651, 1154, 2557, 3135, 4062, 4672, 6296, 6461, 6772, 7178, 9111, 9535, 9970, 10362, 13552, 13724, 13822, 14196, 14328, 15499, 18929, 23340, 24136, 25204, 25413, 28807, 29389, 30253, 30442, 1897, 232, 1126, 2264, 3863, 3976, 4192, 5286, 6228, 6756, 7562, 8044, 8468, 8470, 9190, 9546, 12404, 12760, 12761, 13711, 14870, 15553, 16953, 17878, 18002, 18233, 18868, 18935, 19074, 20989, 24408, 24662, 25568, 25838, 26529, 26736, 27316, 27397, 1898. 1338, 2149, 2926, 3247, 4507, 5760, 6523, 6656, 7352, 8409, 8679, 8680, 9062, 10071, 11345, 12316, 12392, 12591, 13171, 16595, 18516, 22712, 23442, 24375, 24377, 1899. 214, 4593, 5830, 7583, 8758, 10450, 11567, 14583, 16277, 17809, 19773, 20133, 20799, 20800, 21065, 21068, 21627, 23252, 23801, 1900. 984, 5231, 6159, 7148, 8101, 8365, 8821, 9994, 11400, 12617, 14231, 14525, 14676, 15141, 16694, 17626, 18161, 20755, 21621, 22966, 23284, 23889, 24118, 25233, 25884, 26617, 1901. 3238, 3334, 4781, 8776, 9043, 9416, 11325, 11503, 13111, 13266, 13348, 14585, 14590, 20214, 21171, 21189, 22645, 23846, 24633, 24812, 24934, 25025, 25540, 26802, 28245, 1902. 457, 2977, 5791, 6689, 7269, 8898, 10789, 10836, 11140, 12584, 13457, 15331, 14825, 14827, 19438, 20216, 20965, 21365, 21481, 21482, 23472, 23766, 24511, 26978, 27515, 28710, 1903. 116, 3253, 3301, 4028, 4699, 4742, 6353, 7490, 8041, 11000, 12627, 14480, 15053, 17880, 18269, 20106, 23366, 23973, 24782, 25797, 26146, 27005, 27162, 27166, 27459, 27460, 27706, 28256, 28376, 28808, 29056, 1904. 3789, 4057, 4372, 4968, 5687, 5985, 6045, 6361, 6651, 8746, 13340, 13603, 14545, 14958, 15564, 15565, 15566, 16514, 17741, 18275, 18692, 19112, 19402, 20310, 21529, 21779, 24002, 25081, 25780, 25781, 25939, 1905. 1573, 2985, 3005, 4114, 4115, 5259, 5965, 6314, 6705, 9791, 10424, 10927, 12716, 12718, 12920, 13983, 16725, 16882, 17414, 17891, 19107, 19215, 19408, 20309, 20889, 21240, 24240, 28053, 29289, 1906. 791, 1784, 2286, 3179, 3199, 4439, 7837, 7838, 8156, 8157, 9170, 10510, 10520, 11369, 16492, 17877, 19565A, 19993, 20931, 21116, 21117, 21360, 23819, 24025, 26261, 26791, 26823, 1907. 351, 1677, 1819, 2509, 3221, 4046, 4468, 7921, 8358, 9572, 10129, 12188, 15195, 15916, 16599, 17767, 19334, 20214, 20279, 20574, 22555, 23192, 28012, 28544, 1908. 3937, 9992, 11179, 12506, 16617, 18270, 18551, 18622, 19395, 19922, 22095, 24286, 25533, 26239, 26359, 28929, 29882, 1909. 555, 2039, 2876, 3224, 3907, 3936, 5707, 8769, 11365, 15410, 20494, 21071, 22030, 23145, 25274, 26334, 27560, 1910.

to-day in substantially the manner perfected by Schultze. He made nitrocellulose by the treatment of finely divided wood with nitric and sulfuric acids, to which was added potassium and barium nitrates, vegetable gelatin and water.

In 1888 A. Nobel pointed the way to the practical solution of the problem by making a colloidal powder, Cordite, composed of nitroglycerol, guncotton and vaseline. Soon after, colloidal powders of nitrocellulose alone were produced, using acetone as a solvent because of the high nitrogen content of the nitro-cotton used at that time.

In the United States,¹ the earlier comprehensive experiments with nitrocellulose smokeless powders commenced in 1892 although sporadic attempts had previously been made. We found ourselves handicapped by being several years behind the times in development and practical experience as regards smokeless powder, and probably even more laggard in respect to high explosives for shell fillers. The first attack on the smokeless powder problem was made in the face of considerable difficulties. In the first place there was a paucity of scientific research along these lines in the United States to furnish precedents and the accumulation of reliable scientific data as a groundwork for the elaboration and perfection of the problem, and but few practical workers were conversant with the manufacturing details of the subject.

Furthermore, the great domestic powder manufacturing plants had been built and equipped for the manufacture of char-

1. A. Anderson, *Mex. Min. J.* **14**, 29, abstr. C. A. 1912, **6**, 2530. H. Aspinwall, *Chem. News*, 1901, **83**, 26. R. Earle, *Ann. Rep. Chief Bur. Ordnance, Navy Dept. (U. S.)*, 1917; abstr. C. A. 1918, **12**, 426. A. Fay, *Bur. Mines, Tech. Paper No. 69*, abstr. C. A. 1914, **8**, 1671; *J. S. C. I.* 1914, **33**, 768. *Tech. Paper No. 175* (1917), abstr. C. A. 1917, **11**, 3432. See also *Tech. Paper No. 159* (1916), abstr. C. A. 1916, **10**, 2524. F. Gunsolus, *J. Cleveland, Eng. Soc.* 1913, **5**, No. 6, 407. W. Hawkins, *J. U. S. Artill.* **38**, 142. L. Henderson, *Proc. U. S. Nav. Inst.* 1904, **30**, 353. C. Munroe, *J. A. C. S.* 1893, **15**, 1, abstr. *Jahr Chem.* 1893, **46**, 2230; *Chem. Centr.* 1893, **64**, II, 306; *Proc. Amer. Soc. Testing Materials*, **9**, 638, 8th Intern. Cong. Appl. Chem., abstr. C. A. 1912, **6**, 3523. *Zts. Schiess. Spreng.* 1910, **5**, 1. F. Morris, *Banker and Investor Mag.* **12**, 609, abstr. C. A. 1912, **6**, 3183. N. Twining, *Rept. Chief Bur. Ordnance, U. S. Navy*, 1911, 1913; abstr. C. A. 1912, **6**, 905, 1914, **8**, 574. F. Willcox, *Engrg. (London)*, 1898, **71**, 690, 725. *Rept. Chief Bur. Ordnance, U. S. Navy*, 1912, 1914; abstr. C. A. 1913, **7**, 702, 1915, **9**, 380. *Anon., Engrg.* **90**, 562, *Daily Cons. and Trade Rep.* **15**, 1180. *Arms and Explo.* 1895, **3**, 165, 189; 1897, **5**, 191. *Iron Age*, **43**, 410. *Sci. Amer. Suppl.* 1892, **33**, 13406, 1892, **35**, 14248. W. Cope, *J. Ind. Eng. Chem.* 1920, **12**, 870.

coal powders, and their owners were not ultra-enthusiastic in developing a new powder which meant the entire reorganization of their technical force and the installation of expensive equipment, together with the discarding of that then in use. If conservatism is synonymous with pessimism, American powder manufacturers at this time, to say the least, were very conservative. Another difficulty which impeded progress and resulted in voluminous acrimonious discussion, was the inability to decide between a nitrocellulose-nitroglycerol powder as typified by Cordite, a pure nitrocellulose powder, and a BN type propellant. But little was definitely known in respect to them in this country at that time, and much that was published was misleading, if not contradictory. No tests had been developed to accurately determine the stability under conditions of service. That they might be responsible for a high rate of bore erosion was not known—or at least sufficiently appreciated—until a year later. Furthermore, the shape of the pressure curve was also unknown, and many of our early built-up guns had been designed for chase pressures incident to black powder propellants.

The array of artillery then in use in the United States service consisted of the 15-inch smooth bore gun, the 8-inch converted rifle, and 37 mm. Hotchkiss light field gun, the 1.65 inch Hotchkiss mountain gun, the 3.2-inch field gun, and the 8-, 10- and 12-inch built-up steel rifles then in the type testing stage. It included also the 12-inch cast iron, steel hooped, rifled mortar, and the 12-inch steel-rifled mortar, both then without carriages other than the 1890 model type carriage undergoing test.

Irrespective of this transition and developmental state of all of our sea-coast guns and carriages, samples of smokeless powder were procured abroad and submitted to test in 1892. One sample was of German manufacture and the other of the French, or BN type. These were tested in the then new 12-inch steel breech loading rifle with astonishing results, so far as the experience of this country was concerned. For the same muzzle velocity, the weight of German powder was to that of brown prismatic powder as one is to three. The corresponding ratio of the BN powder was as one is to two. Furthermore, the maximum chamber pressures with the smokeless powders were less than with the brown powder. The differences were so great and so

apparent that the new powders were suspected of being capable of detonative action, and attempts were accordingly made to detonate them with mercury fulminate, but without success.

In this year also, the 0.30-caliber Krag rifle was adopted for the service, and that led to parallel efforts to obtain a smokeless powder for the small arms cartridge. In fact, it may be said that the development of a satisfactory powder for that arm was depended upon to point the way for the selection of a smokeless powder for cannon. To this end, samples of Wetteren, Troisdorf, Maxim and Houghton smokeless small arms powders were obtained and forwarded to Frankford Arsenal for exhaustive examination. An ordnance officer of experience was especially detailed there to conduct tests with smokeless powders and to develop the chemical laboratory work involved. The earlier tests of smokeless powder as to stability were, as compared with present practice, extremely crude and abbreviated. They consisted primarily in exposing the powders to varying degrees of heat in an attempt to simulate actual storage conditions, especially in the assembled cartridge. The KI test was known and applied—150° F. and 15 min. being, respectively, the minimum temperature and time required.

In the ensuing year (1893) a number of samples of smokeless small arms powders were received at Frankford Arsenal, and included Peyton, Leonard, du Pont, Axtell and Alters powders of domestic origin, Wetteren, Troisdorf, BNF, Swiss, Rifleite, S.R., and S.V. powders representing those of foreign manufacture. The Peyton powder was the only one of domestic manufacture considered worthy of note, while the standard of excellence as determined by the test to which it was submitted—was the Wetteren, with the Troisdorf also highly esteemed.

Of smokeless powders for cannon, BN, German, U. S. Navy Smokeless, Cordite, Troisdorf, and Leonard powders were received and tested. The French BN powder was then in considerable favor, as it contained no nitroglycerol, an ingredient even then, much distrusted in this country. Firings with these powders were made in 12-, 8-, 5-, 4 72- and 3.2-inch guns. Troisdorf, a nitrocellulose powder of German manufacture, appeared to be much in favor as the result of the tests to which it had been submitted, and was free from nitroglycerol, it giving unusually

uniform ballistics. Powders of the Cordite type gave results not so favorable.

The subject of erosion in the bores of cannon first arose in this country at this time, and added another uncertainty and fruitful source of polemics to the already perplexing problem of the selection of a suitable smokeless powder. It was contended that if erosion was inevitable, the guns might be relined—an opinion which has since found expression in practice.

The situation in 1894 was but little changed. Congress was insistent that a powder of domestic manufacture should be officially adopted, and every effort was made to stimulate the efforts and enlist the cooperation of private powder manufacturers to produce a satisfactory straight nitrocellulose powder. To this end an ordnance officer was specially detailed at the works of the du Pont Company, and provided with suitable ordnance at the works for testing the samples. The samples were dilatory in forthcoming, as they had to be made by hand or in hastily improvised machinery, and in comparatively small lots. Another officer was detailed to the Pacific Coast to the Peyton Powder Co., and a proving ground was constructed at Benicia Arsenal.

In this year the first ballistic specifications for nitrocellulose smokeless powder were drawn up and were as follows:

Gun	Muzzle Velocity.	Maximum Chamber Pressure
5-inch Siege	1830 f s	31360 lbs per sq inch
7-inch Siege	1085 f s	26880 lbs per sq inch
8-inch Steel Rifle	2000 f s	33600 lbs per sq inch
10-inch Steel Rifle	2025 f s	33600 lbs per sq inch

Various granulations were used, cord, strip, cube, and multi-perforated. In the latter, 19, 21 and 7 perforations were employed. In 1895, Peyton smokeless powder (nitroglycerol) began to be regularly used in loading .30 caliber small arms cartridges, the service having been completely equipped with the new Krag rifles by May first of that year.

In the two succeeding years, experiments with cannon smokeless powders were continued, and in 1897 the first smokeless powder was issued to the service for use in target practice with the 3 6-inch mortar. Contracts were also placed during this year with domestic firms for Peyton, Rottweil, W. A., and

nitroglycerol powders for 12-, 10- and 8-inch guns. These contracts were allotted to the California Powder Co., the American Ordnance Co., the Laflin & Rand Co., and the du Pont Co. Also Peyton smokeless powder was definitely adopted and used throughout the year in loading .30 caliber small arms cartridges for the Krag service magazine small arm. No further orders for charcoal powders were contemplated by the Chief of Ordnance.

As indicative of the status of artillery practice in 1897, the following table of allowances published in a general order, may be of interest:

Gun.	Projectiles per Battery.	Powder.
3.2-inch Field Gun	{ 18 shrapnel } 7 shell	IK
3.6-inch Field Mortar	{ 7 shrapnel } 8 shell	Smokeless
8-inch M. L. Conv'd Rifle	{ 10 chilled shot } Butler or Fureka	Hexagonal
8-inch } 10-inch } B. L. Steel 12-inch } Rifles	{ 3 shots each: 2 at 1725 f. s., and 1 at 2025 f. s. }	Brown Prismatic
12-inch B. L. Mortar	3 shots	Black Mortar
10-inch S. B.	10 shots	Mammoth
15-inch S. B.	8 shots	Sphero-Hexagonal

(All shots at stationary targets.)

As germane to the subject of propellants, it may be stated that the Haskell multi-charge gun was tested at this time and found deficient; also that pneumatic guns were under test on the Pacific coast; while at the same time the Sims-Dudley gun was receiving consideration.

During the biennial period, 1898-1899, the situation with respect to smokeless powder made little advancement of an enduring character in the United States, the domestic manufacturers above enumerated being just turning out their several types of smokeless powders in large quantities for the first time. A slight and temporary check to this work occurred in 1899, when all work on the manufacture of smokeless powder was suspended on account of the destruction of an 8-inch and a 10-inch rifle at Sandy Hook, when smokeless powder manufactured in 1897 was being used. Upon investigation, however, confidence was again restored in the smokeless powders under manufacture, and the work was resumed. The powders giving

the destructive pressures were found to be not of the type being manufactured and were found to have become brittle. This led to the introduction of the compression test of smokeless powders.

During the Spanish-American War of 1898, considerable newspaper agitation occurred on the subject of our defenseless condition as to a supply of smokeless powder, but this gradually quiesced when it became generally known that all of the then existent powder plants were working to maximum capacity. The general trend of scientific opinion was slowly, but none the less surely, turning during these years towards the ultimate adoption of a straight nitrocellulose powder, until in 1900, such a type was definitely and officially decided upon for cannon. At this time the rapid erosion of English guns under Cordite powder had become generally known, and that knowledge undoubtedly weighed heavily in arriving at the above decision.

In 1900 sufficient confidence in the ability to produce good, common smokeless powder had been gained to warrant the placing of large additional orders with domestic manufacturers; but still the service was without a smokeless powder except that for the 3.8-inch field mortar. In the ensuing year (1901), however, smokeless powder was also issued for the 3-inch 15 pounder D.S. gun; and incidentally, it is interesting to note at this point that moving targets were first used in target practice in that year.

To increase the knowledge of smokeless powders and of other ordnance material, two ordnance officers were dispatched to Europe in 1901 to investigate and report upon these subjects. Their visit had valuable results in many lines of ordnance work. New stability tests for smokeless powder were adopted, so that by the close of the year 1901 the following tests were used instead of the KI test alone:

- (a) Potassium iodide test.
- (b) Vieille 110° test. Later discarded.
- (c) Will Explosion test. Discarded later.
- (d) Troisdorf or German 135° test.

About this time arose the suspicion that certain substances, if present in only traces, might inhibit or mask the standard stability tests and thus render them useless. This matter was

- investigated and the use of certain ingredients forbidden.

It was in 1901 that there was first demonstrated in the United States the danger attendant upon the use of smokeless powder for saluting or blank charge purposes, the demonstration consisting in the entirely unexpected destruction of a 3-inch, 15 pounder D.S. gun. It was subsequently learned that similar accidents had occurred abroad.

The undue length of time consumed in the drying of smokeless powder, especially of the larger granulations, having been brought to the attention of the Ordnance Department, various schemes to expedite the process were suggested. The expedient of drying in hot water for the removal of the solvents, and later drying in air was tested, and discarded as the stability and ballistics obtained under this process were erratic. The study of smokeless powder continued during the following year, and resulted in the addition of the 115° Ordnance Department test; also in the discovery of certain basic laws relating to nitrocellulose and the colloid made therefrom, e. g.:

(a) After a certain point has been reached, smokeless powder deteriorates more rapidly when hermetically sealed than when in the open air; and

(b) That finished powder is not as stable as the nitrocellulose from which it is made.

Much consideration was given to the subject of strip or tubular powders instead of the multiperforated grain in order to make the powder charge less unwieldy and apt to clog the breech box in inserting. A serious objection to long tubular powders was found to be in the intense blow-pipe action of the combustion gases emitted from the bores of the tubular powder. Strip powders were unsatisfactory due to a well defined lack of progressivity.

• By 1903, the production of smokeless powder was fairly well understood, and the manufacture of it progressed with greater confidence. The cause of the development of critical pressures in the case of several powders was investigated, and, as a result, the powder specifications were modified so as to include a compression test and thus insure a tough powder free from brittleness. The critical pressures were found to occur between 38,000 and 40,000 lb. per square inch. The action

at this point was such that for a very slight increase in the charge, a disproportionately greater increase in the maximum chamber pressure results. It was found that acetone as a colloiding agent was in some measure responsible for brittleness in the finished product.

Although a straight nitrocellulose powder had been definitely decided upon for cannon, nitroglycerol powder was still used for the small arm propellant, inasmuch as its keeping qualities seemed to be much better; and inasmuch as it did not give excessive erosion when used with the 220 grain blunt nosed bullet, and the finally adopted muzzle velocity. This powder, therefore, continued to be used until the advent of the 150 grain sharp-pointed bullet in 1906. In the year 1903 all artillery practice for the first time was carried out with smokeless powder.

In the following year the quality of brittleness was further investigated, and many ballistic tests made in this connection. It was established that good nitrocellulose powder when heated continuously at 150°-180° F. gave increased pressures and velocities up to a certain time, after which these qualities diminished. The reason for this phenomenon was not determined, but has repeatedly been corroborated.

In 1905 the specification for the manufacture of nitrocellulose cannon powder was further improved. The stability tests were increased in severity, and greater care in the purification of the guncotton was required. The relative hygroscopicity of nitrocellulose smokeless powders was also investigated, and while it was at first believed that increased moisture in smokeless powder resided only on its surface as an occlusion or condensation, this was later disproved. Had this theory been correct the increase in moisture for various granulations would have been directly proportional to their surface areas; whereas experiment showed that increase in moisture in all granulations approached a common maxima lying between 2.5% and 3%.

The Joint Army and Navy Powder Board first convened in 1906 for the purpose of further improving smokeless powder specifications, and soon adopted the same specifications for army and navy powders, in addition to making minor improvements in the specifications adopted.

The serious accidents which occurred in the Navy due to

flarebacks, brought up this subject for serious consideration in respect to the sea-coast artillery. Tests were made, but it was early demonstrated that for guns mounted in open air such phenomena would not occur. That combustible gases were present, however, was clearly shown by holding a lighted match at the mouth of a cartridge case extracted from a gun immediately after firing.

The adoption of the model of 1906 small arms cartridge with its light pointed bullet led to difficulties in erosion in the model 1903 service rifle, and the major portion of the years 1906-1907 were taken up in endeavors to solve this difficulty, more than 100 samples of powder being examined. The adoption of the present pyro or nitrocellulose powder is the result of these deliberations, thus terminating the history of nitroglycerol powders in the United States Army or Navy. The new small arms pyro powder gave excellent results, so that the accuracy life was increased from less than 1000 to more than 10,000 shots.

This Joint Board continued its labors and the Army and Navy powder specifications were made identical. The influence of aldehyde in alcohol had always been much feared, and the specifications had always prohibited its presence in the ethyl alcohol, even in minute quantities. Upon investigation, however, it transpired that this substance, even if present in the alcohol to the extent of 5%, caused no decrease in the stability of the finished powder.

The undue lengths of time required in the drying of smokeless powder, especially of the larger granulations, still engaged the attention of the authorities, and quick drying powders were considered and tested, but with indecisive results. During this year the Coast Artillery service first received authority to re-blend and weigh smokeless powder charges for service practice, and thus was initiated the interesting discussions between the "blenders" and the "anti-blenders." Whatever may have been the ballistic result of blending, it is certain that it was justified by the awakening of increased interest in the Coast Artillery.

This Board was again active in 1909 in still further improving the smokeless powder specifications, especially as to the granulations best adapted to the several service guns and mortars involved. Efforts were made to reduce the maximum pressures,

and thus to permit of an increase in the muzzle velocity. The subject of bore fouling was also considered, with a view to reducing the amount and hardness of the deposit. In this year the Army Powder Factory at Picatinny, New Jersey, was completed, and the work of installing a small experimental plant for the manufacture of high explosives inaugurated.

In the three succeeding years, up to 1912, the situation in the United States in respect to nitrocellulose smokeless powder remained in a quiescent state so far as marked changes are concerned, there being many improvements of a minor nature. These have consisted in changes looking toward the further stabilization of the powder, the cheapening in cost of production of the product, and acceleration in methods of manufacture, especially in respect to the length of time of drying. In this latter point, some remarkable improvements have comparatively recently been inaugurated, the disclosure of which as yet has not been made public.

In 1911 our smokeless powder was attacked in the foreign press on the ground that it could not be safely fired when heated as high as 150° F., due to the multi-perforated type of grain and the composition of the powder. This point was promptly taken up and firings made with a powder preheated to 208° F. with no excessive pressures not accounted for by the usual temperature compensation. From 1912 until the period when the United States entered the war, improvements in smokeless powder manufacture were of minor importance. From 1915 to the present time (1920) many unusually important discoveries have been made and refinements devised, notably in decreasing from several weeks to one to two days, the time required to dry smokeless powder; the perfection of the mechanical method of cotton nitration; the utilization of wood cellulose in the production of powders of high stability and satisfactory ballistics; and refinements in the manufacture of nitrocellulose centrifugally on the large scale.

Much has been written as to the comparative advantages and disadvantages of a straight nitrocellulose smokeless powder such as is used in the United States, and the nitrocellulose-nitroglycerol powders, typified by the English cordite. In contending the high position of the nitrocellulose powders—especially those

produced since 1907 attention is directed to the destruction of the Aquidaban (cordite), the Jena (inferior nitrocellulose), the Mikasa (cordite), and the Liberte (inferior nitrocellulose). The claims put forward for the superiority of nitrocellulose to nitrocellulose-nitroglycerol powders, are:

(1) Nitrocellulose of a lower nitration is used, this permitting of better purification and giving a nitrocellulose of more acceptable stability.

(2) Nitrocellulose is insensible to ordinary shock at all temperatures, whereas at moderately high temperatures cordite exudes nitroglycerol and becomes sensitive to shock.

(3) With the stabilizers now in use, nitrocellulose powder may be expected to withstand a storage of 20 years, as against a much less time for cordite.

(4) The temperature of explosion of nitrocellulose powder is about 50°C less than the corresponding temperatures for cordite, with consequent decreased progression in gun erosion.

(5) The chemical decomposition of nitrocellulose powder in storage is at all times gradual, and does not reach a critical stage beyond which the rate of decomposition is greatly accelerated and terminated by explosion. Conversely, cordite is somewhat treacherous in this respect, giving good stability tests for perhaps a number of years, and then suddenly decomposing within a few months to a dangerous condition, sometimes terminating in explosion.

Various controversial discussions on this subject are appended below.¹

The development of the U. S. Navy smokeless powder, in many respects, has been entirely different from the Army powder previously detailed. Neither the Army nor Navy powders have been the same as the French Poudre B,² with which it has sometimes erroneously been compared to its detriment.³ The U. S. guncotton factory at the Torpedo Station, Newport, had been set in operation in March 1884, the smokeless powder manu-

¹ A. Busson, *Zts. Schiess Spreng* 1913, **8**, 368, 393; abst C. A. 1904, **8**, 249. J. Hardeastle, *Arms and Explo* 1914, **22**, 93; abst C. A. 1914, **8**, 2948. Anon., *Engng* **89**, 649; 1911, **92**, 338. Report of the U. S. Joint Army and Navy Powder Board, *Proc. U. S. Nav. Inst.* 1912, **38**, 133, abst C. A. 1912, **6**, 1367.

² See *Proc. U. S. Nav. Inst.* 1911, **37**, 1281.

³ See *Proc. U. S. Nav. Inst.* 1912, **38**, 132.

facture having been started in a very modest manner in 1881. Actual powder manufacture as the outgrowth of this preliminary investigation seems to have been formally established by the Secretary of the Navy in 1890, when manufacture of indurite was commenced under the supervision of the inventor, C. Murroe. In 1891 the manufacture of indurite was carried on in somewhat extensive manner, this being a single base powder in which the nitrocellulose was gelatinized with nitrobenzene. By indurating the plastic mass produced by the colloidizing action of the nitrobenzene upon the nitrocotton, the colloidizing agent was removed. Samples of this indurite made in 1891 were perfectly stable in 1914.¹

A process and the necessary machinery were then developed for producing indurite, which was used experimentally in gun up to and including 6 inch. Several cases of instability having developed in this powder, led to other lines of research, and its manufacture was soon discontinued.

A single base powder of guncotton, barium and potassium nitrates, was next produced, but this was on account of its brittleness superseded by a product corresponding to the French powder that was then being manufactured for sale and similar to that used at present in the French navy, in that it contains two types of nitrocelluloses. This contained soluble and insoluble nitrocellulose, barium and potassium nitrates, and was colloidized at first with acetone, but afterwards with ethyl alcohol. Patents were taken out on this powder in 1895 by G. Converse and J. Bernadou.²

In the summer of 1895, a sample of smokeless powder was received from Russia, being produced there as the result of the theoretical investigations of Mendeleeff, who deduced the percentage of nitration for the nitrocellulose required to obtain the greatest gas volume under ballistic conditions, as 12.41, from which the following equation results $C_{10}H_{18}(NO_2)_{12}O_{25}$, when exploded in a gun, breaks down into 30 CO, 19 H₂O and 12 N₂.

The year 1896, then, is the date of adoption of the present U. S. Navy powder. In the year previous, however, there were three private explosive plants all operating independently in

1. J. U. S. Artill. 1914, **42**, 235.

2. U. S. P. 550472, 551306.

the United States, in which the manufacture of such a powder was feasible. These plants were the Laffin & Rand at Haskell, N. J., the du Pont works at Carney's Point, N. J., and one concern on the west coast known as the California Powder Works, which manufactured its nitrocellulose at Pinole, and the remaining portion of its powder at Santa Cruz. These companies differed widely in their methods and machinery, but all undertook contracts for U. S. Navy smokeless powder upon specifications based on the experimental work carried out at Newport.

The first nitrocellulose powder delivered by a private firm was proved in June 1897, and was made at the Carney's Point plant of the du Pont Company, the powder being designated as S.P. 3. The California Powder Works, in July 1898, had its first product known as S.P. 7 proven, and similarly the Haskell plant had its first powder proven in May 1899, known as S.P. 34.

The Bureau of Ordnance decided in September 1897 to build a powder plant and under date of Sept. 28th, T. McLean, inspector in charge of the Torpedo Station, appointed a board consisting of K. Niles, H. Brown, K. Hedberg and F. Kniffen to prepare plans and specifications for a factory having a capacity of 1000 pounds per day. These plans were submitted on Mar. 31, 1898, and specifications were given on the Apr. 20th following. In July 1898, Congress made available the funds for the erection of a navy factory to be located at Indian Head, Maryland, about 20 miles below Washington, on the Potomac River, it then being the site of our ordnance proving ground. The erection was soon under way, and the first completed powder grain run out on June 28, 1900, J. Strauss being then in charge of the factory. It was a gnarled and spotted grain—somewhat of a contrast between the present day powder—but it was a *beginning*. The first complex index of powder made at Indian Head was known as S.P. 148, and this was proved in Feb. 1901.

A fourth private plant was built at about this time at Parlin, N. J., and was called the International Smokeless Powder & Chemical Co. This company obtained its supervising force from men at the Torpedo Station, where they had been trained in the investigations, developments and machinery requisite to produce navy powder. The company obtained contracts from the Navy Department by underbidding the other three private firms by

one cent per pound. The first index of powder delivered by them was known as S.P. 199, and was proved in April 1902.

It is thus seen that four firms commenced the manufacture of cannon powder shortly after the beginning was made by the U. S. Government plant at Newport, which plant had delivered the navy's first index of smokeless powder in season to be proved in March 1896. The Navy Department gradually transferred its powder manufacture to the Indian Head plant, and none is now made at Newport.

The dehydration process by which the water remaining in the nitrocellulose after its washings is replaced by alcohol and the excess of alcohol then squeezed out hydraulically, was brought about by F. du Pont and applied by him at Carney's Point in 1897. The combination of these two processes into the one receptacle was worked out by W. Peyton at the California Powder Works.

For many years the navy powder was a pure nitrocellulose colloid, but the necessity of having the many people under whose care it was placed from time to time, familiar with its stability led to an endeavor to incorporate stability indicators into the powder. Rosaniline, which colored the powder a brilliant red, was introduced at Indian Head in 1902, incorporated in 1907, and although a success there, was abandoned because the different plants manufacturing powder for the Navy did not turn out a product uniform in color, due partly to their water supply, and partly to storage of the rosaniline in copper instead of galvanized tins. The first incipient decomposition fades the color entirely.

The early days of nitrocellulose powder were attended with many setbacks, lack of stability often developing from causes difficult to ascertain. The waste due to this cause led to strenuous efforts to utilize the unstable and doubtful powders as well as to determine how to increase the stability. A method of powder reworking was perfected by the du Pont Co., at Carney's Point, and after a successful demonstration, the process was turned over to the Navy. Reworked powder is uniformly opaque, instead of possessing the translucency of the new product.

Because of the long period consumed in drying the powder—thereby causing a delay in the use of the larger granulations until practically four months after its manufacture, much energy

was devoted in endeavors to materially shorten this drying period, but with no marked success, until comparatively recently.

In 1909, after considerable discussion for and against, it was decided to incorporate with the powder an organic stabilizer. There had been many used in other countries from time to time, such as urea, amyl alcohol, nitroguanidine and diphenylamine, but reliable reports as to their relative efficiency were lacking. The substance chosen as the result of a European trip made in 1898 by H. Brown was diphenylamine, which is used at the present day for this purpose in the United States. The first lot of powder in which this stabilizer was incorporated was turned out at Indian Head in July 1909, private companies having used it since November 1908.

Stabilite, the invention of Hudson Maxim, was sold to the du Pont Company, and by them communicated to the Navy. It is a smokeless powder made with non-volatile solvent, and said to be ready for use immediately after granulation. From 1910 up to the present, the history of development of navy powder is blended with that of the army, touched upon in the foregoing pages of this topic.

Classification of Nitrocellulose-containing Powders. For the purpose of this historical résumé, smokeless powders may be subdivided into the two broad classes: (a) those for use in rifled firearms, and (b) those for use in shot guns. The former class is comprized in two main divisions, i. e., those consisting primarily of nitrocellulose only, and those containing, in addition, notable proportions of nitroglycerol.

Of the straight nitrocellulose powders, the official powders of Russia, France and the United States belong to this category while those of England, Spain, Italy and Germany (partially) are comprehended in the nitroglycerol classification.

Another classification is based upon three subdivisions as follows: (a) Nitrocellulose only, either soluble in a mixture of alcohol-ether or insoluble. To this category belong the French Poudre B., the Russian powders including the pyrocollodion powder of Mendeleeff used in the Russian navy; the Belgian powder of Wetteren, the German flake powder, and the Austrian Schwab powder. (b) Combining nitrocellulose with nitro-

glycerol. Cordite, ballistite, filite, composed of the two above together with relatively small amounts of other ingredients as vaseline, camphor, aniline, diphenylamine, etc., and the Austrian gunpowder model 1893, composed of nitroglycerol and insoluble nitrocotton. (c) Containing nitrocellulose and mixed nitrates, as indurite, combinations of nitrocotton with inorganic nitrates, chlorates and with a variety of organic bodies, as alluded to briefly subsequently.

Of the straight nitrocellulose powders, methods of manufacture and properties are detailed in the patented processes and products of W. Wolf and M. von Forster,¹ Totten,² J. Donald and J. Macaulay,³ E. Turpin,⁴ C. Pieper,⁵ D. Johnson,⁶ F. Liebeck,⁷ J. Macnab,⁸ A. Broadbent and R. Woodbridge,⁹ H. Maxim,¹⁰ R. Punshon,¹¹ C. Volney,¹² A. Luck,¹³ C. Lundholm and J. Sayers,¹⁴

1. E. P. 3866, 1883, abst. J. S. C. I. 1881, **3**, 378, Mon. Sci. 1911, **74**, 156. E. P. 13522, 1884, abst. J. S. C. I. 1885, **4**, 243. E. P. 7640, 1885, abst. J. S. C. I. 1885, **4**, 467. F. P. 164792, 1881, abst. Mon. Sci. 1885, **27**, 491. D. R. P. 23808, 1883, abst. Wag. Jahr. 1883, **29**, 389, Chem. Ind. 1883, **6**, 250, 348, Ber. 1883, **16**, 2542, Chem. Tech. Rep. 1883, **22**, II, 188. D. R. P. 26014, abst. Wag. Jahr. 1884, **30**, 377, Chem. Ind. 1884, **7**, 31, 165, Chem. Tech. Rep. 1884, **23**, I, 201, Bull. Soc. Chim. 1884, **42**, 398, Poly. Notizb. 1884, **39**, 187.

2. See M. Hissler, "Modern Explosives," 1897, 112. Totten's gun powder is said to consist of grains the kernel of which is pure gun cotton.

3. Can. P. 191040, 1920.

4. E. P. 4310, 1888, abst. J. S. C. I. 1889, **8**, 61, Proc. U. S. Nav. Inst. 1889, **15**, 312.

5. E. P. 2547, 1890, abst. J. S. C. I. 1891, **10**, 161.

6. E. P. 8951, 1885, abst. J. S. C. I. 1886, **5**, 678, Ber. 1887, **20**, 181-R, Wag. Jahr. 1887, **33**, 570. U. S. P. 376000, 1888.

7. E. P. 27397, 1898, abst. J. S. C. I. 1899, **18**, 401.

8. E. P. 2926, 1899, abst. J. S. C. I. 1900, **19**, 375. See also E. P. 16777, 1897, abst. J. S. C. I. 1898, **17**, 795.

9. U. S. P. 1313459, 1919. E. P. 127871, 1917, abst. J. S. C. I. 1919, **38**, 604-A, 743-A.

10. U. S. P. 430212, abst. J. A. C. S. 1890, **12**, 240. E. P. 16213, 1888, abst. J. S. C. I. 1889, **8**, 852, 918. E. P. 16858, 1896, abst. Arms and Explo. 1897, **5**, 203. F. P. 194792, abst. Mon. Sci. 1889, **33**, 756. D. R. P. 49154, abst. Zts. ang. Chem. 1890, **3**, 59, Jahr. Chem. 1890, **43**, 2708, Chem. Tech. Rep. 1889, **28**, II, 173, Wag. Jahr. 1889, **35**, 475, Ber. 1890, **23**, 42-R, Industriell. 1890, 87, Tech. Chem. Jahr. 1889, **12**, 160. U. S. P. 951445, F. P. 412029, abst. C. A. 1910, **4**, 1516, J. S. C. I. 1910, **29**, 518, 1038, Mon. Sci. 1910, **73**, 120, 1911, **75**, 175, Chem. Ztg. Rep. 1910, **34**, 171.

11. F. P. 91749, 1871, abst. Bull. Soc. Chim. 1872, **17**, 142, Ber. 1873, **14**; Amer. Chemist, 1873, **4**, 29.

12. E. P. 25204, 25413, 1897, F. P. 271840, 271842, 1897, U. S. P. 592485, 1897, abst. Mon. Sci. 1898, **52**, 238, Rev. chim. ind. 1898, **9**, 95, Arms and Explo. 1898, **6**, 80.

13. Can. P. 67833, 1900, E. P. 25939, 1905, abst. J. S. C. I. 1906, **25**, 1119.

14. Can. P. 35253, 1890. See also D. R. P. 53296, 55650, 1889, abst. Zts. ang. Chem. 1890, **3**, 556, 1891, **4**, 469.

A. Nobel,¹ V. Vender,² C. Munroe,³ A. Luck and C. Cross,⁴ A. Cocking and Kynoch, Ltd.,⁵ Westfälisch Anhaltische Sprengstoff A.-G.,⁶ C. Curtis,⁷ O. Schmidt,⁸ S. von Romocki,⁹ W. Reid and D. Johnson,¹⁰ J. Bernadou,¹¹ W. Borland,¹² I. and A. Anderson,¹³ R. Griffith, E. Durnford and G. Wadsworth,¹⁴ F. and E. du Pont, and Ball Grain Explosives Co.,¹⁵ G. Andre,¹⁶ J. Bickford,¹⁷ J. France,¹⁸ New Explosives Co., and J. Carter,¹⁹ M. von Förster,²⁰ F. Engel,²¹

1. Can. P. 30707, 1889.
2. Span. P. 46082, 1909; U. S. P. 946294; abst. C. A. 1910, **4**, 671; Mon. Sci. 1910, **73**, 120; Chem. Ztg. Rep. 1910, **34**, 143.
3. U. S. P. 489684, 1893; abst. J. S. C. I. 1893, **15**, 356.
4. E. P. 18233, 1898; abst. Arms and Explo. 1899, **7**, 131; Mon. Sci. 1900, **55**, 131. Can. P. 68050, 1900.
5. E. P. 15053, 21779. 1905; 25081, 1906; abst. Arms and Explo. 1905, **13**, 105; J. S. C. I. 1905, **24**, 814; 1906, **25**, 953.
6. Swiss P. 41004.
7. Can. P. 41524, 1893.
8. D. R. P. 286784, 1913; abst. C. A. 1916, **10**, 179; J. S. C. I. 1916, **35**, 276; Chem. Zentr. 1915, **86**, II, 732; Chem. Ztg. Rep. 1915, **39**, 239; Wag. Jahr. 1915, **61**, I, 270; Zts. ang. Chem. 1915, **28**, II, 542.
9. D. R. P. 54818; E. P. 18727, 1889; abst. Mon. Sci. 1891, **37**, 91; Ber. 1891, **24**, 420-R; Chem. Ind. 1891, **14**, 98; Chem. Tech. Rep. 1891, **30**, I, 218; Tech. Chem. Jahr. 1890-91, **13**, 156; Chem. Ztg. 1891, **15**, 80, 1058; 1892, **16**, 1277; Jahr. Chem. 1891, **44**, 2667; Meyer Jahr. Chem. 1891, **1**, 333; Wag. Jahr. 1890, **36**, 543; Zts. ang. Chem. 1891, **4**, 33.
10. U. S. P. 267108, 1882; E. P. 619, 1882; D. R. P. 18950; Can. P. 14413, 1882; F. P. 147325, 1882; Aust. P. April 24, 1883; abst. J. S. C. I. 1882, **1**, 76; Mon. Sci. 1883, **25**, 617; 1911, **74**, 156; Chem. Ind. 1882, **5**, 255, 245; Chem. Tech. Rep. 1882, **21**, II, 175; Chem. Tech. Mitth. 1882-3, **32**, 97; Dingl. Poly. 1882, **246**, 185; Jahr. Chem. 1882, **35**, 1411; Wag. Jahr. 1882, **28**, 404; 1883, **29**, 389.
11. U. S. P. 586586, 652455, 652505, 673377; abst. Mon. Sci. 1900, **56**, 216; J. A. C. S. 1902, **24**, 104. F. P. 301649, 307918; abst. Mon. Sci. 1901, **57**, 305; 1902, **58**, 158. E. P. 2253, 1901; 11567, 1900; abst. J. S. C. I. 1900, **19**, 851; 1901, **20**, 617. See also Rev. Prod. Chim. 1901, **3**, 341; abst. J. S. C. I. 1901, **20**, 154. D. R. P. 125100; abst. Mon. Sci. 1902, **58**, 145; Chem. Centr. 1901, **72**, II, 1140; Chem. Ztg. 1901, **25**, 1019; Chem. Zts. 1902, **1**, 255, 405; Wag. Jahr. 1901, **47**, I, 490; Zts. ang. Chem. 1901, **14**, 1213. D. R. P. 127143; abst. Mon. Sci. 1902, **58**, 145; Chem. Ztg. 1901, **25**, 1174; Chem. Zts. 1902, **1**, 405; Jahr. Chem. 1902, **55**, 1056; Wag. Jahr. 1902, **48**, I, 360; II, 490; Zts. ang. Chem. 1902, 19.
12. E. P. 4593, 1900; abst. J. S. C. I. 1900, **19**, 296; 1901, **20**, 279; Mon. Sci. 1901, **57**, 287; Chem. Ztg. 1901, **25**, 619.
13. E. P. 13308, 1888; abst. J. S. C. I. 1889, **8**, 818.
14. E. P. 13171, 1899; abst. J. S. C. I. 1900, **19**, 560.
15. U. S. P. 1308342, 1308343, 1308344, 1308346, 1308347, 1919; abst. J. S. C. I. 1919, **38**, 605-A; C. A. 1919, **13**, 2283.
16. U. S. P. 575765, 1897; E. P. 19068, 1891; Norw. P. 3201, 1892; Can. P. 41524, 1893; abst. J. S. C. I. 1891, **10**, 971; 1892, **11**, 960. U. S. P. 576532, 1897; E. P. 11383, 1891; abst. J. S. C. I. 1891, **10**, 674, 746, 855; Chem. Centr. 1892, **63**, I, 112; Mon. Sci. 1898, **52**, 95; Chem. Ztg. 1897, **21**, 160.
17. U. S. P. 47677, 1865.
18. U. S. P. 356094, 1887.
19. D. R. P. 210934; abst. Chem. Ztg. Rep. 1909, **33**, 361; Wag. Jahr.

W. Eberlein,¹ H. Pipitz,² and including the work of E. Prentice.³

Another class of explosives comprizes nitrocellulose admixed with inorganic nitrates as of potassium, sodium and ammonium, occasionally with the incorporation of relatively small amounts of other bodies. To this category belong the processes and products put forward by P. Abel,⁴ J. Bantock,⁵ C. Claessen,⁶ H. Cottu,⁷ C. Curtis and G. Andre,⁸ J. Donald and J. Macauley,⁹ F. Sparre,¹⁰ Eales,¹¹ M. Eissler,¹² C. Faure and G. Trench,¹³ A. Favier,¹⁴ D. Johnson,¹⁵ A. Hargreaves,¹⁶ D. Hickie and G. Beutner,¹⁷ M. Himalaya,¹⁸ R. Imperiali,¹⁹ A. Cocking and Kynoch, Ltd.,²⁰

1909, **55**, I, 429; Zts. ang. Chem. 1909, **22**, 1614; Zts. Schiess. Spreng. 1909, **4**, 293. See also Engineering, **89**, 123; abst. C. A. 1910, **4**, 963.

20. D. R. P. 83095; abst. Mon. Sci. 1896, **48**, 72; Ber. 1895, **28**, 957, Chem. Ztg. 1895, **19**, 1923; Wag. Jahr. 1895, **41**, 460; Zts. ang. Chem. 1895, **8**, 573. See also N. Erfind. Erfahr. 1892, **19**, 43.

21. E. P. 6022, 1887; abst. J. S. C. I. 1887, **6**, 398; 1888, **7**, 56; 1889, **8**, 818.

1. U. S. P. 1098237; abst. C. A. 1914, **8**, 2622; Mon. Sci. 1914, **81**, 188.

2. E. P. 18935, 1898; abst. Arms and Explo. 1899, **7**, 158; D. R. P. 114499, 114500; abst. Mon. Sci. 1901, **57**, 48, 147; Chem. Centr. 1900, **71**, II, 1004; Chem. Ztg. 1900, **24**, 41, 933, 954; Jahr. Chem. 1900, **53**, 849; Wag. Jahr. 1900, **46**, I, 395, 396; Zts. ang. Chem. 1900, **13**, 1141.

3. E. P. 2468, 1877; D. R. P. 690, 1877, abst. Chem. Ind. 1878, **1**, 127; Wag. Jahr. 1878, **24**, 466, 467.

4. E. P. 14803, 1886; abst. Chem. Tech. Rep. 1888, **27**, I, 168; Chem. Ztg. 1888, **12**, 430; Tech. Chem. Jahr. 1887-8, **10**, 188.

5. E. P. 4806, 1876.

6. E. P. 24240, 1906; abst. C. A. 1907, **1**, 2646; J. S. C. I. 1907, **26**, 991. E. P. 16456, 1913; abst. J. S. C. I. 1914, **33**, 845.

7. F. P. 402693, 1908; abst. Mon. Sci. 1911, **75**, 175.

8. E. P. 16595, 1899; abst. J. S. C. I. 1900, **19**, 851; Arms and Explo. 1900, **8**, 148. See also E. P. 9062, 1899; 19773, 1900; abst. J. S. C. I. 1900, **19**, 467; 1901, **20**, 1240.

9. Can. P. 191040, 1919; abst. C. A. 1919, **13**, 1766.

10. U. S. P. 812958, 850267, 850268, 850325, 850502; abst. Mon. Sci. 1906, **65**, 121; 1907, **67**, 160; C. A. 1907, **1**, 1786, 1773; J. S. C. I. 1907, **26**, 785; Zts. Schiess. Spreng. 1906, **1**, 221; 1907, **2**, 436, 457, 437. E. P. 1677, 1908; abst. J. S. C. I. 1909, **28**, 922; Zts. Schiess. Spreng. 1909, **4**, 194.

11. F. P. 184326, 1887; abst. Mon. Sci. 1888, **32**, 635.

12. U. S. P. 347424; abst. Wag. Jahr. 1886, **32**, 319.

13. E. P. 3781, 1874; abst. Ber. 1876, **9**, 650; Dingl. Poly. 1876, **221**, 94; Deut. Industrieztg. 1876, 228; Wag. Jahr. 1877, **23**, 479.

14. E. P. 6875, 1888; abst. J. S. C. I. 1888, **7**, 416, 470. See also E. P. 2139, 1885; abst. J. S. C. I. 1885, **4**, 141, 468.

15. E. P. 8951, 1885; abst. Wag. Jahr. 1887, **33**, 570; Ber. 1887, **20**, 181-R; J. S. C. I. 1886, **5**, 678.

16. E. P. 24235, 1894; 15351, 1896; abst. J. S. C. I. 1895, **14**, 988; 1897, **16**, 560.

17. E. P. 12084, 1894; abst. J. S. C. I. 1894, **13**, 782; 1895, **14**, 540, 594.

18. E. P. 3179, 1907; U. S. P. 853085; abst. C. A. 1907, **1**, 2181, 2189, 3070; J. S. C. I. 1907, **26**, 1029; Mon. Sci. 1907, **67**, 160; Zts. Schiess. Spreng. 1908, **3**, 116.

19. U. S. P. 998007, 1911; abst. C. A. 1911, **5**, 2952; Mon. Sci. 1912,

- J. Lehmann,¹ D. de Lome,² A. Luck and C. Nichols,³ S. Mackie,⁴ S. Mackie and C. Faure,⁵ S. Mackie, C. Faure and G. Trench,⁶ J. Macnab,⁷ A. Martin,⁸ H. Maxim,⁹ A. Nobel,¹⁰ J. Okell,¹¹ L. O'Shea and C. Brooks,¹² G. Peters, M. Lindsley and the King Powder Co.,¹³ T. Petry, O. Wallenstein and H. Lisch,¹⁴ T. Reishoff,¹⁵ Roburite Explosives Co., C. Roth and W. Orsman,¹⁶ J. Sayers,¹⁷ T. Schaffner,¹⁸ E. Schultze,¹⁹ J. Schulhof,²⁰ O. Silberrad,²¹ I. von 77, 159; Zts. Schiess. Spreng 1912, **7**, 101. Swiss P. 55035, 1911.
20. E. P. 15566, 1905; abst. J. S. C. I. 1906, **25**, 609; Chem. Ztg. 1906, **30**, 487; Zts. Schiess. Spreng 1906, **1**, 262.
1. E. P. 351, 1908; abst. J. S. C. I. 1908, **27**, 922.
2. Compt. rend. 1878, **87**, 1005; abst. Jahr Chem. 1878, **31**, 35.
3. E. P. 24136, 1897; abst. Mon. Sci. 1899, **53**, 75; Chem. Ztg. 1899, **23**, 203.
4. E. P. 4230, 1880; abst. J. A. C. S. 1882, **4**, 41; Chem. Ind. 1884, **4**, 180, 223; Wag. Jahr 1881, **27**, 330.
5. E. P. 1830, 1873; abst. Chem. News, 1874, **29**, 166; Dingl. Poly. 1874, **213**, 174; Ber. 1874, **7**, 741; Jahr Chem. 1874, **27**, 1123.
6. E. P. 2062, 1874; abst. Ber. 1876, **9**, 205; Bayer. Industrie u. Gewerbebl. 1876, 141; Wag. Jahr 1876, **22**, 480; Chem. Tech. Rep. 1876, **15**, 388; Zts. Chem. Grossgewerbe, 1876, **1**, 233.
7. E. P. 2926, 1899; abst. J. S. C. I. 1900, **19**, 375.
8. U. S. P. 1206456; abst. C. A. 1917, **11**, 211; J. S. C. I. 1917, **36**, 48.
9. E. P. 6926, 1885; abst. J. S. C. I. 1886, **5**, 186, 678.
10. E. P. 5382, 1884; abst. J. S. C. I. 1885, **4**, 417. E. P. 1469, 1888; abst. J. S. C. I. 1889, **8**, 78, 133.
11. D. R. P. 114500, 114499; abst. Mon. Sci. 1901, **57**, 147, 148; Chem. Centr. 1900, **71**, II, 1004; Chem. Ztg. 1900, **24**, 933, 954; Jahr Chem. 1900, **53**, 849; Wag. Jahr. 1900, **46**, I, 395, 396; Zts. ang. Chem. 1900, **13**, 1140, 1141. The corresponding E. P. 18935, 1898 (abst. Arms and Explo. 1899, **7**, 158), has been taken out for H. Pipitz.
12. E. P. 4394, 1879.
13. U. S. P. 953798, 1910; abst. C. A. 1910, **4**, 1678; Mon. Sci. 1910, **73**, 126.
14. D. R. P. 31786; abst. Berg- u. hüttenm. Ztg. 1885, 65; Wag. Jahr. 1885, **31**, 284; Chem. Tech. Rep. 1885, **24**, I, 201; Chem. Ind. 1885, **8**, 183, 190, 220; Poly. Notizbl. 1885, **40**, 316; Ber. 1885, **18**, 471-R; Dingl. Poly. 1885, **256**, 409; Jahr. Chem. 1885, **38**, 2103. F. P. 163256; abst. Mon. Sci. 1885, **27**, 196. Can. P. 21848, 1885.
15. E. P. 10927, 1906; abst. C. A. 1906, **1**, 507; J. S. C. I. 1906, **25**, 868; Zts. Schiess. Spreng 1906, **1**, 450.
16. E. P. 20104, 1889; abst. J. S. C. I. 1891, **10**, 253, 270; 1889, **8**, 1831; 1890, **9**, 1090.
17. E. P. 17212, 1888; abst. J. S. C. I. 1889, **8**, 1009; Wag. Jahr. 1890, **36**, 546; Chem. Ztg. 1890, **14**, 671; Chem. Tech. Rep. 1890, **29**, I, 224. See also C. Lundholm and J. Sayers, E. P. 6399, 1889; abst. Dingl. Poly. 1890, **278**, 20; J. S. C. I. 1890, **9**, 414; Tech. Chem. Jahr. 1890-91, **13**, 153.
18. U. S. P. 139738, 1872; abst. Amer. Chemist, 1873, **4**, 159.
19. E. P. 15129, 1885; abst. J. S. C. I. 1886, **5**, 186, 679. D. R. P. 38363; abst. Wag. Jahr. 1887, **33**, 572; Ber. 1887, **20**, 237-R; Industriebl. 1887, 232; Chem. Ind. 1887, **10**, 76, 189; Chem. Tech. Rep. 1887, **26**, I, 231; Jahr Chem. 1887, **40**, 2599; Tech. Chem. Jahr. 1886, **9**, 208.
20. E. P. 4917, 1882, 1767, 1883; abst. J. S. C. I. 1883, **2**, 191; Ber. 1883, **16**, 2941; Jahr. Chem. 1883, **36**, 1705; Wag. Jahr. 1884, **30**, 377.
21. E. P. 13442, 13443, 1911; abst. C. A. 1912, **6**, 3525; J. S. C. I. 1912,

Tarnow,¹ W. Theodorovic,² J. Thompson,³ C. Tisell,⁴ J. Tonkin,⁵
 Vereinigte Koln-Rottweiler Pulverfabriken,⁶ A. Verge,⁷ and H. Wessel.⁸

Similarly compounded nitrocellulose powders in which the nitrates are replaced by chlorates or perchlorates, form the essence of the processes of J. Rudeloff and A. and W. Allendorff,⁹ S. Adde,¹⁰ E. Bjorkman,¹¹ W. Borland,¹² F. Bowen,¹³ C. Demetriade, C. Jonescu and J. Coanda,¹⁴ Deutsche Sprengstoff A.-G.,¹⁵ M. Fiedler,¹⁶ M. Himalaya,¹⁷ W. Kirsanow,¹⁸ G. Kope,¹⁹ E. Landauer,²⁰ T. Petry and O. Fallenstein,²¹ W. Pierce,²² W. Riskmers,²³ A.

31, 703, Chem Ztg Rep 1912, **36**, 506, Zts. Schiess. Spreng 1912, **7**, 420; E. P. 13860, 1911, abst. C. A. 1913, **7**, 4, J. S. C. I. 1912, **31**, 627; U. S. P. 1040793, 1040794, abst. C. A. 1912, **6**, 3525, Mon. Sci. 1913, **79**, 13, Zts. Schiess. Spreng 1913, **8**, 179.

1. E. P. 465082, 1913, abst. C. A. 1914, **8**, 3366, Mon. Sci. 1916, **83**, 68.

2. E. P. 949, 1896, abst. Arms and Explo 1896, **4**, 135, J. S. C. I. 1896, **15**, 68, 236, 376, Mon. Sci. 1897, **50**, 168, 1898, **52**, 95, Chem Ztg 1897, **21**, 479.

3. U. S. P. 1291258, 1919, abst. J. S. C. I. 1919, **38**, 269 A, C. A. 1919, **13**, 906.

4. E. P. 116890, 1918, abst. C. A. 1918, **12**, 2143.

5. E. P. 320, 1862, abst. Mon. Sci. 1910, **72**, 728.

6. D. R. P. 303979, 1917, abst. J. S. C. I. 1920, **39**, 282 A.

7. E. P. 17205, 1913, abst. J. S. C. I. 1914, **33**, 943. See also E. P. 17128, 1913, abst. J. S. C. I. 1914, **33**, 890. In this connection compare J. Sayers, W. Wilson and J. Thorburn, U. S. P. 999375, abst. C. A. 1911, **5**, 2725, Mon. Sci. 1912, **77**, 158, Chem Ztg Rep 1911, **35**, 642.

8. E. P. 2286, 1907, abst. C. A. 1907, **1**, 2649, J. S. C. I. 1907, **26**, 948; Mon. Sci. 1910, **73**, 44, Zts. Schiess. Spreng 1907, **2**, 413.

9. D. R. P. 201306, E. P. 322994, abst. Mon. Sci. 1912, **77**, 51, Chem. Zentr. 1908, **79**, 11, 999, Chem Ztg Rep 1908, **32**, 511, Chem Zts 1909, **8**, 1027, Wag. Jahr 1908, **54**, I, 437, Zts. Schiess. Spreng 1908, **3**, 374.

10. India P. 3516, 1918.

11. E. P. 2459, 1875, abst. Dent. Industrietztg 1876, **58**, Chem. Tech. Rep. 1875, **14**, II, 216; Zts. Chem. Grossgewerbe 1876, **1**, 233, Chem. Tech. Mitth. 1877, **27**, 340.

12. E. P. 6289, 1895, abst. Arms and Explo 1896, **4**, 122; J. S. C. I. 1896, **15**, 152, 214.

13. U. S. P. 857580, abst. C. A. 1907, **1**, 2504, J. S. C. I. 1907, **26**, 899; Zts. Schiess. Spreng 1908, **3**, 18. E. P. 21481, 21482, 1903, E. P. 346812, abst. J. S. C. I. 1904, **23**, 1238, Mon. Sci. 1906, **65**, 75, Chem Ztg 1903, **29**, 126. India P. Appl. 118, 1905.

14. E. P. 26359, 1909, abst. J. S. C. I. 1910, **29**, 1476.

15. Can. P. 23850, 1886. See D. R. P. 36061, abst. Wag. Jahr. 1886, **32**, 319; Chem. Ind. 1886, **9**, 200, 361, Industriebl. 1886, 399, Chem. Tech. Rep. 1886, **25**, II, 297, Ber. 1886, **19**, 636, Tech. Chem. Jahr 1887-8, **10**, 188, Jahr. Chem. 1886, **39**, 2081.

16. E. P. 8101, 23284, 1901, abst. J. S. C. I. 1901, **20**, 837, 1902, **21**, 723. India P. Appl. 394, 1902. Can. P. 84306.

17. E. P. 421202, 1910, abst. Mon. Sci. 1913, **79**, 26.

18. E. P. 6159, 1901, abst. J. S. C. I. 1902, **21**, 561.

19. E. P. 27560, 1910, abst. C. A. 1912, **6**, 1528; J. S. C. I. 1912, **31**, 47.

20. E. P. 19267, 1891, abst. J. S. C. I. 1892, **21**, 804, 1932. E. P.

Johnston and L. Dow,¹ Societe en actions "Promethee,"² L. Thomas,³ J. Thompson,⁴ C. Tisell,⁵ E. Turpin,⁶ and M. v. Wendland.⁷

Other additions which have been proposed as adjuncts to nitrocellulose include chromates, bichromates⁸ and those of potassium⁹ or ammonium;¹⁰ ammonium chloride,¹¹ ammonium oxalate,¹² picrate,¹³ lead,¹⁴ or manganese oxides,¹⁵ ferrosilicon,¹⁶ lead or silver azides,¹⁷ calcium sulfate,¹⁸ and other bodies.¹⁹

Nitrocellulose-nitroglycerol Powders. Of these, Cordite, the official powder of the British Government,²⁰ is the best known, and undoubtedly has reached an unusually high degree of perfection in the various steps of manufacture.²⁰ The defects developed

216053, 1891; abst. Mon. Sci. 1893, **42**, 19.

21. E. P. 10986, 1884; abst. J. S. C. I. 1885, **4**, 468, 509. D. R. P. 31786; abst. Dingl. Poly. 1885, **256**, 408; Wag. Jahr. 1885, **31**, 284; Chem. Tech. Jahr. 1885, **8**, 185.

22. E. P. 22240, 1912; abst. C. A. 1914, **8**, 1014; J. S. C. I. 1913, **32**, 1171; Chem. Ztg. Rep. 1914, **38**, 211.

23. Can. P. 127209, 1910.

1. E. P. 2601, 1861.

2. Swiss P. 27514, 1902.

3. U. S. P. 790089; abst. J. A. C. S. 1906, **28**-R, 48; Mon. Sci. 1905,

63, 141. E. P. 8746, 1905; abst. J. S. C. I. 1905, **24**, 986; Zts. Schiess. Spreng. 1906, **1**, 17. See also E. P. 12837, 1885; abst. J. S. C. I. 1886, **5**, 516.

4. U. S. P. 1291258, 1919; abst. C. A. 1919, **13**, 906.

5. E. P. 116890, 1918; abst. J. S. C. I. 1919, **38**, 513-A.

6. E. P. 4310, 1888; abst. J. S. C. I. 1888, **7**, 364, 894; 1889, **8**, 61.

7. D. R. P. 36718; abst. Wag. Jahr. 1886, **32**, 322; Tech. Chem. Jahr. 1886, **9**, 206; 1887, **10**, 47.

8. S. Davey, E. P. 2832, 1877; abst. Chem. Ind. 1878, **1**, 108; Wag. Jahr. 1878, **24**, 466.

9. W. Borland, E. P. 6280, 1895; abst. J. S. C. I. 1895, **14**, 418; 1896, **15**, 152, 214.

10. See Mem. poud. salp. 1884-9, **2**, 24; 1890, **3**, 13; 1892, **5**, 25, 215.

11. P. Allyre, F. P. 443555; abst. C. A. 1913, **7**, 1291; Mon. Sci. 1913, **79**, 186; Chem. Ztg. Rep. 1913, **37**, 450.

12. J. Macnab, E. P. 16777, 1897; abst. Arms and Explo. 1898, **6**, 198; J. S. C. I. 1898, **17**, 721, 795.

13. C. Claessen, E. P. 16456, 1913; abst. C. A. 1915, **9**, 153; J. S. C. I. 1914, **33**, 845.

14. H. Maxim, U. S. P. 988799; abst. C. A. 1911, **5**, 2179; Mon. Sci. **40**-12, **77**, 31; Chem. Ztg. Rep. 1911, **35**, 330; Zts. Schiess. Spreng. 1912, **7**, 17.

15. C. Prentice, E. P. 174, 1877.

16. Superfosfat Fabriks Aktiebolag, E. P. 17583, 1915; abst. J. S. C. I. 1917, **36**, 307; C. A. 1917, **11**, 1751.

17. Soc. d'Etudes Chimique pour L'Industrie, E. P. 130166, 1918; abst. C. A. 1920, **14**, 124.

18. L. Mack, E. P. 12584, 1903; abst. J. S. C. I. 1903, **22**, 952.

19. C. Curtis and G. Andre, E. P. 16595, 1899; abst. J. S. C. I. 1900, **19**, 467, 851.

20. For general data on Cordite see Arms and Explo. 1895, **3**, 74, 91, 110, 131, 133, 164, 187, 191, 199, 210; **4**, 9, 16, 204; 1896, **4**, 80, 81; **5**, 9, 19,

in the earlier forms of ballistite, mainly due to attempts to incorporate camphor and other organic bodies into the mass, it is claimed have been obviated in the manufacture of cordite. The English Government through F. Abel and J. Dewar obtained patent protection¹ the year before Nobel's ballistite patent was granted, for an explosive in which nitroglycerol combined with nitrocotton is compounded with the addition of a small amount of vaseline.²

The original product, to which the name of "Cordite" was

37; 1897, **5**, 89, 106, 109; 1898, **6**, 150, 158, 238; 1899, **7**, 41, 1900, **8**, 14, 131, 1901, **9**, 67; 1903, **11**, 26, 63, 83; 1905, **13**, 54, 122, 1907, **15**, 86, 163, 1908, **16**, 44; 1909, **17**, 2; 1910, **18**, 85, 100. The Cordite Case is discussed in Arms and Explo. 1892-3, **1**, 259; 1893, **2**, 2, 20, 108, 134, 135, 183, 188, 199, 207; abst. Chem. Ztg. 1894, **18**, 229, 255, Dingl. Poly. 1894, **292**, 18. See also Mem. Artilleria, Feb. 1908; abst. Zts. Schiess Spreng 1908, **3**, 215. Chem. Drug. Feb. 1, 1902; abst. J. S. C. I. 1902, **21**, 294. Mitt. Seewesen, 1907, **35**, 798. Ann. Repts H. M. Insp. Explo. 1890, 63, 1892, 65, 1897, 62. Zts. Schiess. Spreng. 1911, **6**, 135. Sci. Amer. Suppl. **35**, 14385. Nature, **84**, 109. Int. Encycl. **5**, 408. Eng. **76**, 126. The New Illustrated (London), 1919, **1**, 189.

1. U. S. P. 425648, 1890; abst. J. A. C. S. 1890, **12**, 125. Belg. P. 87455, 1889; South Australia P. 1418, 1889. Can. P. 32219, 1889. E. P. 8718, 1889; abst. J. S. C. I. 1889, **8**, 500; 1890, **9**, 580, 764. E. P. 5614, 1889, abst. J. S. C. I. 1890, **9**, 792; Mon. Sci. 1911, **74**, 157. E. P. 11664, 1889, abst. Dingl. Poly. 1890, **275**, 115; J. S. C. I. 1890, **9**, 765, Tech. Chem. Jahr. 1890, **13**, 163. F. P. 198946, 200275, 1889; abst. Mon. Sci. 1890, **35**, 327, 437. D. R. P. 51189, 53294; abst. Chem. Tech. Rep. 1890, **29**, 1, 223, 11, 144; Chem. Ind. 1890, **13**, 167, 375; Wag. Jahr. 1890, **36**, 541, Ber. 1890, **23**, 370-R; 1891, **24**, 181-R; Mon. Sci. 1890, **36**, 650, 1199; 1892, **39**, 288, Tech. Chem. Jahr. 1889, **12**, 170; 1890, **13**, 162; Jahr. Chem. 1890, **43**, 2708, Meyer Jahr. Chem. 1891, **1**, 333.

2. No doubt Nobel's ballistite patent paved the way for the combination of nitroglycerol with nitrocellulose, but H. S. Maxim preceded (E. P. 18663, 1888; 4477, 1889) Abel and Dewar in a measure, although whereas Maxim mentioned the addition of 2%-10% nitroglycerol to an acetone solution of gumcotton, this was omitted in the complete specification. For the question of whether the English Government did or did not pirate the ideas of Nobel and Maxim in obtaining Cordite, see reports of various lawsuits abstracted in Arms and Explosives. A. Nobel's patents are: E. P. 1470, 1888; abst. Proc. U. S. Nav. Inst. 1889, **15**, 313; J. S. C. I. 1889, **8**, 133. E. P. 1471, 1888; abst. J. S. C. I. 1889, **8**, 214; Tech. Chem. Jahr. 1890, **13**, 160; Chem. Tech. Rep. 1890, **29**, 1, 224; Zts. ang. Chem. 1889, **2**, 345, Jahr. Chem. 1889, **42**, 2682; Wag. Jahr. 1889, **35**, 474. U. S. P. 456504; abst. J. A. C. S. 1891, **13**, 220. F. P. 185179; abst. Mon. Sci. 1888, **32**, 750. Belg. P. 80419, 1888. Ital. P. 22994, 1888. D. R. P. 4829; abst. Zts. Chem. Grossgewerbe, 1879, **4**, 288; Chem. Ind. 1879, **2**, 171; Chem. Ztg. 1879, **3**, 197; Chem. Tech. Rep. 1879, **18**, 1, 288; Dingl. Poly. 1879, **232**, 486; see also Chem. Tech. Rep. 1877, **16**, 1, 486; Jahr. Chem. 1879, **32**, 115; J. A. C. S. 1879, **1**, 304; Wag. Jahr. 1878, **24**, 467; Chem. Tech. Mitth. 1878-9, **28**, 293. D. R. P. 42452; abst. Chem. Tech. Rep. 1888, **27**, 1, 165; Chem. Ind. 1888, **21**, 441; Wag. Jahr. 1888, **34**, 491; Ber. 1888, **21**, 334-R; Mon. Sci. 1888, **32**, 1332; Industriell. 1888, 215; Chem. Tech. Jahr. 1887, **10**, 191. D. R. P. 45712, 1888; abst. Ber. 1889, **22**, 40-R; Wag. Jahr. 1888, **34**, 502; Chem. Ind.

applied,¹ consisted of nitroglycerol 58%, guncotton insoluble in nitroglycerol 37%, and mineral jelly, a product of distillation of crude petroleum 5%. To effect the gelatinization of the guncotton, 19.2 parts of acetone were employed. The large proportion of nitroglycerol present resulted in a very high heat of explosion, and the erosion produced on the rifling of the guns, especially in the high calibers, was considerable. This led to experiments being carried out in 1890, as the result of which a less erosive explosive was evolved, to which was given the name "Cordite M.D.," or of "M.D.S. Cordite," and in which the nitroglycerol is reduced to 30%, the other constituents being guncotton,² 65%, and mineral jelly,³ 5%.

Details of the development of cordite smokeless powder

1889, **12**, 65; Chem. Tech. Rep. 1888, **27**, II, 225, Tech. Chem. Jahr. 1888, **11**, 187. D. R. P. 51471, 1889; abst. Jahr. Chem. 1890, **43**, 2708, Chem. Ztg. 1890, **14**, 670; 1892, **16**, 1278; Chem. Tech. Rep. 1890, **29**, I, 223; Chem. Ind. 1890, **13**, 167; Wag. Jahr. 1890, **36**, 541, Ber. 1890, **23**, 528; Mon. Sci. 1891, **37**, 426; 1905, **62**, 87; Meyer Jahr. Chem. 1891, **1**, 333, Tech. Chem. Jahr. 1889, **12**, 168, 1892, **15**, 175. D. R. P. 56785, abst. Zts. ang. Chem. 1891, **4**, 307; Chem. Ztg. 1891, **15**, 964; 1892, **16**, 1278; Chem. Tech. Rep. 1891, **30**, I, 220; Chem. Ind. 1891, **14**, 400, Wag. Jahr. 1891, **37**, 434; Ber. 1891, **24**, 1004-R; Mon. Sci. 1891, **37**, 426, Meyer Jahr. Chem. 1891, **1**, 334; Tech. Chem. Jahr. 1890, **13**, 161.

1. So called on account of the string-like or cord-like appearance

2. For the manufacture of cordite, the British Government specifies that the cotton waste used shall not contain over 5% moisture, over 1% ash, or more than 0.8% fat when ether extracted in a Soxhlet. The guncotton, which contains, as a rule, not over 10% of soluble guncotton, is made by the Thomson Displacement Process of nitration, as described on page 1978, with the following differences. The composition of the nitrating acid is said to be sulfuric acid 70.6%, nitric acid 21%, nitrous acid 0.6%, and water 7.9%. The quantity in each pan above the bottom plates is 600 lb., and below the plates is an additional 50 lb. A charge of 20 lb. of cotton waste is then immersed in the acid handful by handful, aluminium dipping forks being used for this purpose. When all the cotton waste has been pushed under the surface of the acid, perforated plates in segments are placed on the top of it, care being taken that all cotton waste is below the surface of the acid and a film of water at a temperature of from 5-8° is run gradually on the surface of the plates through a distributor.

The nitration is allowed to proceed for a maximum of two hours, at the expiration of which time a cock is opened and the acid allowed to run off at the rate of 17 lb. a minute. Water, cooled if necessary, is run on to the top of the perforated plates through the distributor at an equivalent rate. The major portion, amounting to about 80% of the total waste acid, is returned to the acid storage tanks to be revived with Nordhausen sulfuric and new nitric acids. The composition of this waste acid is: 72.7% sulfuric acid, 17.30% nitric acid, 0.65% nitrous acid, 9.35% water. The remaining 20% of the waste acid is sent to the acid concentration factory for denitration and concentration. The quantity of acid thus dealt with amounts to about 4 lb. for every pound of guncotton. Its composition is: 61.00% sulfuric acid, 17.35% nitric acid, 0.55% nitrous acid, 21.10% water. A small proportion

from the various angles of manufacture, mechanical and chemical, and the products which have been proposed as substitutes

of the water which follows the recoverable waste acid is slightly acid to the extent of about 0.1 lb. for every pound of guncotton made. This is the total quantity of acid that is lost during the process.

According to Kynoch, Ltd., and A. Cowking (E. P. 157, 1903) in the manufacture of explosives, such as "Cordite M. D.," containing a high proportion of guncotton (65%) danger arises during the hand-mixing and subsequent incorporation in the kneading machines, because the proportion of nitroglycerol is insufficient to moisten the whole of the guncotton. To minimize the danger arising from this dry guncotton dust, it is proposed to dissolve the nitroglycerol in its own volume of methylated spirit before adding it to the guncotton, and thus a thorough wetting of the latter is obtained. The acetone is added, as usual, in the incorporating machine, but a smaller quantity will suffice. Any other volatile liquid ingredient, such as ether, benzene, or naphtha, will also serve the purpose, provided it dissolves nitroglycerol, and does not gelatinize guncotton, and is used in sufficient proportion to thoroughly moisten the guncotton.

3. F. L. Nathan (Discourse delivered at Roy. Inst., Jan. 29, 1900, reprinted Chem. News, 1900, 99, 136, 152, 159) says "Cordite in the advanced experimental stage consisted of nitroglycerol and guncotton alone, and as their combustion produced no solid residue of any kind, the surface of the bore of the magazine rifle in which the early experiments took place was not fouled in any way. The result was that the cupro-nickel coated bullets, propelled in succession at high velocity through a clean barrel, deposited some of the cupro-nickel in the bore. In order to prevent this a number of substances were incorporated with the nitroglycerol and guncotton, with the object of producing a deposit of the bore, which it was hoped would get rid of the difficulty of metallic fouling. Of all these various substances the one which appeared to answer the purpose most satisfactorily was refined vaseline, and this material became the third ingredient of cordite as eventually introduced into the British Service. When the manufacture was commenced on large scale, vaseline, which is the proprietary name of one of the refined products of the distillation of petroleum, was replaced by mineral jelly, the same material, but in a cruder form.

"The original object with which mineral jelly was introduced was of no importance when cordite was substituted for the black and brown powders used in large guns, but in order to have but one nature of smokeless powder in the service, mineral jelly was added to all cordite whether for use in small arms or artillery. Subsequent experience has demonstrated how very fortunate was the selection of this material for rifle cordite and the extension of its use to all sizes of cordite.

"Mineral jelly is one of the best ingredients it is possible to have in smokeless powders from the point of view of their chemical stability. This important fact, not recognized originally, was brought out in the following way. In order to facilitate the explosion of cordite in blank ammunition for the rifle, it was cut into very thin flakes, and the non-explosive mineral jelly was omitted from its composition. After a comparatively short storage in a hot climate, the stability of the smokeless blank, as it was called, was found to have suffered seriously, whereas the stability of normal cordite containing mineral jelly was not appreciably affected. These facts led to a thorough investigation at Waltham Abbey of the action of mineral jelly in preserving the stability of cordite, and it was discovered that mineral jelly contained constituents which had the valuable property of combining with the decomposition products (the result of prolonged storage of cordite at high temperatures) to form stable bodies, thus removing these decomposition products, which undoubtedly exert a deteriorating influence on the cordite,

or as adjuncts of this powder, are to be found in the publications of E. Anderson,¹ W. Bate,² A. Bremberg,³ A. Brock and C. Brock & Co.'s "Crystal Palace" Fireworks, Ltd.,⁴ C. Duttenhofer,⁵ L. Fredman and R. Donaldson,⁶ S. Grant and A. Rützebeck,⁷ W. Greaves and E. Hann,⁸ O. Guttmann,⁹ F. W. Jones,¹⁰ Kynoch, Ltd., and A. Cocking,¹¹ L. Le Brocqy,¹² C. Lees and J. Petavel,¹³ F. from their sphere of action."

In the E. P. 18269, 1904, L. Le Brocqy, claim is made for the employment, in the manufacture of cordite, of a pure or refined hydrocarbon oil or jelly such as "white mineral jelly" or *paraffinum liquidum*, with or without the addition of paraffin wax or ceresin or both, in place of the "semi-crude mineral jelly" usually employed. The deterioration which cordite suffers on exposure to heat and light or by mere storage for a length of time is stated to be due to the fact that the "semi-crude mineral jelly" employed in its manufacture becomes partially nitrated owing to its content of olefines and naphthenes.

1. Arms and Explo 1898, **6**, 71. Inst. Civ. Eng. 1898-9, **136**, part II. E. P. 20286, 1889; abst. J. S. C. I. 1891, **10**, 161. E. P. 12303, 1891; abst. J. S. C. I. 1891, **10**, 746; 1892, **11**, 294, 547. D. R. P. 57427; abst. Wag. Jahr. 1891, **37**, 442; Ber. 1892, **25**, 97-R; Zts. ang. Chem. 1891, **4**, 470.

2. E. P. 25233, 1901; abst. J. S. C. I. 1902, **21**, 562; Chem. Ztg. 1903, **27**, 375.

3. Arms and Explo. 1899, **7**, 172.

4. E. P. 2392, 1913.

5. E. P. 364413, 1906; and additions 6620, 7749, 1906, 1907; abst. J. S. C. I. 1906, **25**, 911; 1907, **26**, 167, 1110. E. P. 791, 1907; abst. J. S. C. I. 1907, **26**, 840. See also C. Claessen, U. S. P. 914113; abst. J. S. C. I. 1909, **28**, 384.

6. Can. P. 190228, 1919; abst. C. A. 1919, **13**, 1533.

7. E. P. 3528, 1913.

8. E. P. 6937, 1896; 651, 1897; abst. J. S. C. I. 1896, **15**, 314; 1897, **16**, 84, 180, 260, 1064; Mon. Sci. 1898, **52**, 95, 266; Chem. Ztg. 1897, **21**, 711; 1898, **22**, 494.

9. Dingl. Poly. 1896, **301**, 15; abst. Wag. Jahr. 1896, **42**, 413. See also Heeres Ztg. **12**, 573.

10. For a comprehensive and valuable series of articles on the ballistics of cordites see F. W. Jones, Arms and Explo. 1904, **12**, 19, 132; 1905, **13**, 88; 1906, **14**, 7; 1907, **15**, 8; abst. Wag. Jahr. 1908, **54**, 1, 450; Zts. Schiess. Spreng. 1906, **1**, 80; 1908, **3**, 317. In this connection consult the patents issued to this worker: E. P. 15553, 1898; abst. J. S. C. I. 1899, **18**, 858; Mon. Sci. 1900, **56**, 131; Chem. Tech. Rep. 1899, **38**, 538; E. P. 18161, 1901; abst. Arms and Explo. 1902, **10**, 146; J. S. C. I. 1902, **21**, 1097. U. S. P. 692142, 692143, 693547, 693548; abst. Mon. Sci. 1902, **58**, 77; J. S. C. I. 1902, **21**, 366, 498. D. R. P. 120201; abst. Chem. Tech. Rep. 1901, **40**, 240; Tech. Chem. Jahr. 1901, **24**, 206; Wag. Jahr. 1901, **47**, 1, 491; Mon. Sci. 1901, **57**, 218; Chem. Ztg. 1901, **25**, 402; Zts. ang. Chem. 1901, **14**, 625; Chem. Zts. 1902, **1**, 117; J. S. C. I. 1914, **33**, 441.

11. E. P. 22190, 1896; abst. Arms and Explo. 1897, **5**, 204. E. P. 20520, 1898; abst. Arms and Explo. 1899, **7**, 131. E. P. 457, 1903; abst. Arms and Explo. 1904, **12**, 13; J. S. C. I. 1903, **22**, 1366. E. P. 15565, 1905; abst. J. S. C. I. 1906, **25**, 609. E. P. 25081, 1906; abst. J. S. C. I. 1906, **25**, 1174; Mon. Sci. 1908, **63**, 116; Chem. Ztg. Rep. 1907, **31**, 216; Zts. Schiess. Spreng. 1907, **2**, 56.

12. E. P. 18269, 1904; abst. Arms and Explo. 1905, **13**, 133; J. S. C. I. 1905, **24**, 986; Mon. Sci. 1906, **65**, 179; Chem. Ztg. Rep. 1906, **30**, 24; Zts.

Lehman,¹ M. Lloyd and Curtis & Harvey, Ltd.,² G. MacRoberts,³ J. Mansell,⁴ H. Maxim,⁵ A. Cooper-Key,⁶ J. Petavel,⁷ Sabulite (Great Britain), Ltd., W. McCandlish, E. and A. Robson,⁸ A. Schaschke,⁹ O. Silberrad, H. Philips and H. Merriman,¹⁰ L. Silvermann,¹¹ J. Thomson,¹² G. Topp,¹³ and Von Witzleben.¹⁴

R. Robertson has pointed out¹⁵ that inasmuch as modified cordite contains a much greater percentage of gumcotton, and, consequently, retains a larger proportion of volatile matter (acetone) than ordinary cordite, he has determined the heat developed by the explosion of modified cordite, which he finds is 200 calories less. E. Crossman¹⁶ has comprehensively compared cordite with other types of powder, and recorded much useful information. The moddite of Ely Bros.¹⁷ is a modified cordite.

Other powders containing both nitrated cellulose and nitro glycerol as their basic materials have been described and are patented by R. Ballabene,¹⁸ C. Bichel,¹⁹ C. Claessen,²⁰ C. Curtis

Schiess. Spreng. 1906, **1**, 17.

13. Proc. Roy. Soc. 1907, **79A**, 277; abst. Nature **76**, 142, C. A. 1907, **1**, 2034; Zts. Schiess. Spreng. 1908, **3**, 166; Wag. Jahr. 1908, **54**, I, 450.

1. E. P. 351, 1908; abst. J. S. C. I. 1908, **27**, 922. F. P. 390381, abst. C. A. 1910, **4**, 2733; Mon. Sci. 1910, **73**, 97.

2. E. P. 27700, 1910; abst. J. S. C. I. 1911, **30**, 836.

3. J. S. C. I. 1890, **9**, 265, 476; abst. Zts. ang. Chem. 1890, **3**, 492. Wag. Jahr. 1890, **36**, 541; Chem. Ztg. 1890, **14**, 379; Chem. Tech. Rep. 1890, **29**, I, 225; II, 146; Jahr. Chem. 1890, **43**, 2705, 2708; Tech. Chem. Jahr. 1890, **13**, 156, 161, 171; Dingl. Poly. 1890, **278**, 418; Mon. Sci. 1891, **37**, 391, Bull. Soc. Chim. 1891, **6**, 518, 521; Rev. Chim. Ind. 1891, **2**, 267; Chem. Ind. 1891, **14**, 74. See also Proc. Phil. Soc. Glasgow, Apr. 25, 1883; abst. Proc. U. S. Nav. Inst. 1885, **11**, 94; Chem. News, 1885, **52**, 165.

4. Phil. Trans. 1907, **207A**, 243; Proc. Roy. Soc. 1907, **79A**, 397, Arms and Explo. 1907, **15**, 106.

5. E. P. 17994, 1894; abst. Arms and Explo. 1895, **4**, 11; J. S. C. I. 1894, **13**, 1010; 1895, **14**, 788, 820.

6. J. S. C. I. 1915, **34**, 736.

7. Brit. Assoc. 1903; Engng. 1903, **76**, 452; abst. J. S. C. I. 1903, **22**, 1148.

8. E. P. 105794, 1916.

9. E. P. 15605, 1913; abst. C. A. 1915, **9**, 153; J. S. C. I. 1914, **33**, 503.

10. Zts. ang. Chem. 1906, **19**, 1601; Chem. Ind. 1907, **25**, 628; Chem. News, 1907, **94**, 80; abst. Wag. Jahr. 1907, **53**, I, 499. O. Silberrad, Engng. June 22, 1906.

11. E. P. 5790, 30735, 1897; abst. Arms and Explo. 1899, **7**, 11.

12. Arms and Explo. 1896, **4**, 60.

13. E. P. 12635, 1905; abst. J. S. C. I. 1906, **25**, 484.

14. Sprengst. Waffen u. Munit. **4**, 38; abst. C. A. 1909, **3**, 1341.

15. Proc. Roy. Soc. 1907, **79A**, 320; abst. J. S. C. I. 1907, **26**, 779.

16. Arms and Explo. 1916, **24**, 103; abst. C. A. 1916, **10**, 2524.

17. See Arms and Explo. 1908, **16**, 18.

18. Glückauf, 1888, No. 78; abst. Wag. Jahr. 1888, **34**, 494. In this connection see also Nature 1881, **3**, 168. Mon. Sci. 1880, **22**, 478. Min.

and G. Andre,¹ F. Ritschke,² C. Duttonhofer,³ W. Goebel,⁴ E. Green,⁵ W. Hargreaves,⁶ A. Cocking and Kynoch, Ltd.,⁷ C. Lundholm and J. Sayers,⁸ H. Maxim,⁹ A. Mikolajczak,¹⁰ V. Vender,¹¹ C. Volney,¹² and the Westfälisch Anhaltische Sprengstoff A.-G.¹³

Other forms and combinations of nitrocellulose with nitro-

J. 1881, **51**, 809. Van Nostrand's Engrg. Mag. 1881, **24**, 160. Judgment of Sir F. Jeune in *Heidemann vs. Smokeless Powder Co., Ltd.*, Arms and Explo. 1898, **6**, 130.

19. U. S. P. 779760, 1905, abst. Mon. Sci. 1905, **63**, 142; J. A. C. S. 1905, **27R**, 542; Chem. Zts. 1905, **4**, 113.

20. U. S. P. 1009577, abst. J. S. C. I. 1911, **30**, 1470, C. A. 1912, **6**, 294; Mon. Sci. 1912, **77**, 159. E. P. 29882, 1909, abst. J. S. C. I. 1911, **30**, 156. E. P. 23145, 1910, abst. C. A. 1911, **5**, 3158; J. S. C. I. 1911, **30**, 385. E. P. 21147, 1911; abst. C. A. 1913, **7**, 1100; J. S. C. I. 1912, **31**, 663. E. P. 24713, 1913. F. P. 410239, 1909, and additions 12430, 13235, 18487; abst. J. S. C. I. 1910, **29**, 842, 1229, 1911, **30**, 448, 1914, **33**, 614. F. P. 368344, 1906; abst. C. A. 1909, **3**, 119, Mon. Sci. 1908, **69**, 139. Can. 130353, 130354, 1911. Dan. P. 14095, 14675, 1911.

1. E. P. 11383, 19068, 1891; abst. J. S. C. I. 1891, **10**, 674, 746, 855, 971; 1892, **11**, 960; Chem. Centr. 1892, **63**, I, 112, 808. Can. P. 41523, 1893. G. Andre, U. S. P. 576532, 1897, abst. Mon. Sci. 1898, **52**, 95, Chem. Ztg. 1897, **21**, 160.

2. U. S. P. 1009577, abst. C. A. 1912, **6**, 294; J. S. C. I. 1911, **30**, 1470, Mon. Sci. 1912, **77**, 159. F. P. 410239, abst. J. S. C. I. 1911, **30**, 448.

3. E. P. 8776, 1902, abst. J. S. C. I. 1902, **21**, 927.

4. Oestr. Zts. Berg- u. Huttenw. 1882, 624, abst. Wag. Jahr. 1882, **28**, 412.

5. U. S. P. 671081, 1901.

6. Arms and Explo. 1914, **22**, 27, J. S. C. I. 1914, **33**, 337, abst. C. A. 1914, **8**, 1508, 2484.

7. E. P. 25081, 1905, abst. J. S. C. I. 1906, **25**, 1174, Mon. Sci. 1908, **69**, 116; Chem. Ztg. Rep. 1907, **31**, 216. E. P. 28178, 1911, abst. C. A. 1913, **7**, 1975; J. S. C. I. 1913, **32**, 111.

8. U. S. P. 438816, 1890; abst. J. A. C. S. 1890, **12**, 418. E. P. 10376, 12338, 1889; abst. J. S. C. I. 1890, **9**, 764, 1891, **10**, 573. D. R. P. 53296, 55650; abst. Mon. Sci. 1891, **38**, 655; Ber. 1891, **24**, 182-R, 429-R; Chem. Centr. 1891, **62**, I, 647, Chem. Tech. Rep. 1890, **29**, II, 145, 1891, **30**, I, 219; Chem. Ztg. 1890, **14**, 1266; 1891, **15**, 567, Meyer Jahr. Chem. 1891, **1**, 332; Tech. Chem. Jahr. 1890, **13**, 162, Wag. Jahr. 1890, **36**, 540, 1891, **37**, 428; Zts. ang. Chem. 1890, **3**, 556; 1891, **4**, 469.

9. U. S. P. 411127, 1889. E. P. 16311, 1895, abst. J. S. C. I. 1895, **14**, 846; 1896, **15**, 942; 1898, **17**, 375, Mon. Sci. 1897, **50**, 168, Chem. Ztg. 1897, **21**, 60. E. P. 28376, 1904; abst. J. S. C. I. 1905, **24**, 457; Mon. Sci. 1911, **74**, 165.

10. F. P. 341911, abst. Mon. Sci. 1905, **63**, 86; Chem. Zts. 1904, **3**, 668; 1905, **4**, 175.

11. E. P. 9791, 1906; abst. C. A. 1907, **1**, 2181, 2193; J. S. C. I. 1907, **26**, 640; Mon. Sci. 1910, **73**, 728, Zts. Schiess. Spreng. 1907, **2**, 374. F. P. 372267, 1906; abst. C. A. 1909, **3**, 249; J. S. C. I. 1907, **26**, 553; Mon. Sci. 1908, **69**, 140; Chem. Ztg. Rep. 1907, **31**, 570.

12. U. S. P. 592485, 1897; abst. Mon. Sci. 1898, **52**, 95. E. P. 25204, 1897; abst. J. S. C. I. 1897, **16**, 958, 1064; 1898, **17**, 69.

13. F. P. 352750; abst. J. S. C. I. 1905, **24**, 987. E. P. 6361, 1905; abst. J. S. C. I. 1906, **25**, 393. M. Bielefeldt, U. S. P. 799705; abst. J. S. C. I. 1905, **24**, 1084.

glycerol, forming the dynamites, gelatins, gelignites and similar propellant and eruptive compounds, are detailed in the processes evolved by S. Adde,¹ U. Alvisi,² American Smokeless Powder Co.,³ W. Anderson,⁴ A. Aubert and S. Nauckhoff,⁵ J. Barab,⁶ C. Bichel,⁷ Birmingham Metal and Munitions Co., Ltd., and J. Barker,⁸ J. Engels,⁹ J. Brown and G. Whistler,¹⁰ R. Brown and C. Lundholm,¹¹ B. Burton,¹² E. Callenburg,¹³ D. Chiaraviglio and B. Parodi-

1. E. P. 13373, 1912, abst. C. A. 1913, **7**, 3843, J. S. C. I. 1913, **32**, 453; Zts. Schiess Spreng. 1913, **8**, 317. E. P. 112618, 1917, abst. C. A. 1918, **12**, 1253, J. S. C. I. 1919, **38**, 513-A. F. P. 470592, abst. Mon. Sci. 1916, **83**, 68. Swed. P. 40482, 1916, abst. C. A. 1916, **10**, 1931.
2. E. P. 25838, 1898, abst. Arms and Explo. 1900, **8**, 35, J. S. C. I. 1900, **19**, 71. Belg. P. 148180, 1900. According to Belg. P. 141646, 1899, the patentee claims to partially or entirely substitute the radical ClO₄ for the NO₂ in cellulose nitrates, thus producing "perchlorcelluloses and perchlor nitrocelluloses."
3. Can. P. 51129.
4. E. P. 28544, 1908, abst. C. A. 1910, **4**, 2206, J. S. C. I. 1910, **29**, 178; Zts. Schiess Spreng. 1910, **5**, 196. Dan. P. Dec. 1908.
5. E. P. 1283, 1915, abst. C. A. 1916, **10**, 1932, J. S. C. I. 1915, **34**, 1118. U. S. P. 1186065, abst. C. A. 1916, **10**, 2045, J. S. C. I. 1916, **35**, 809, Mon. Sci. 1917, **84**, 56. Swed. P. 40297, 1916, abst. C. A. 1916, **10**, 1597.
6. U. S. P. 1307034, abst. C. A. 1919, **13**, 2281.
7. U. S. P. 779760, abst. J. A. C. S. 1905, **27R**, 542, J. S. C. I. 1905, **24**, 152, Mon. Sci. 1905, **63**, 142; Chem. Zts. 1905, **4**, 113. U. S. P. 839450, abst. Mon. Sci. 1907, **67**, 160. U. S. P. 887027, abst. C. A. 1908, **2**, 2731, J. S. C. I. 1908, **27**, 593, Mon. Sci. 1909, **71**, 127, Zts. Schiess Spreng. 1908, **3**, 336. U. S. P. 925419, abst. C. A. 1909, **3**, 2227. E. P. 15528, 1885, abst. J. S. C. I. 1885, **4**, 762, 1886, **5**, 112, 457. E. P. 23846, 1902, abst. J. S. C. I. 1903, **22**, 1103. E. P. 16882, 1906, abst. C. A. 1908, **2**, 2050, 2034, J. S. C. I. 1907, **26**, 552, Zts. Schiess Spreng. 1907, **2**, 277. F. P. 325507, abst. J. S. C. I. 1903, **22**, 710, Mon. Sci. 1904, **61**, 16. F. P. 327868, abst. Mon. Sci. 1905, **63**, 84, Chem. Zts. 1903, **2**, 613, 715. F. P. 356964, abst. C. A. 1907, **1**, 1325, 1344, Mon. Sci. 1907, **67**, 10. F. P. 369371, abst. C. A. 1909, **3**, 249, Mon. Sci. 1908, **69**, 139. Swiss P. 42736. Belg. P. 160239, 1902. D. R. P. 180685, 1902, abst. Wag. Jahr. 1907, **53**, I, 422, C. A. 1907, **1**, 2436.
8. E. P. 992, 2834, 2835, 1911, abst. C. A. 1912, **6**, 1991, J. S. C. I. 1911, **30**, 1335; 1912, **31**, 470. In this connection see also W. Beardmore & Co. and A. Bremberg, E. P. 143757, 1919.
9. E. P. 163, 1880. D. R. P. 10232, 1879, abst. J. A. C. S. 1880, **2**, 405; Ber. 1880, **13**, 1765; Chem. Ind. 1880, **3**, 276; Chem. Tech. Rep. 1880, **19**, I, 339, Deut. Industrieztg. 1880, 401. D. R. P. 36705 (addition to D. R. P. 10232), abst. Wag. Jahr. 1886, **32**, 319, Chem. Ind. 1886, **9**, 269, 362, Chem. Tech. Rep. 1886, **25**, II, 298, Ber. 1886, **19**, 801.
10. U. S. P. 648723, 666485, 1901.
11. E. P. 11458, 1894, abst. J. S. C. I. 1894, **13**, 688, 1895, **14**, 590, 418, Mon. Sci. 1896, **48**, 64.
12. E. P. 12743, 1887. F. P. 192819, 1888, abst. Mon. Sci. 1889, **34**, 633.
13. U. S. P. 644403, 1900. E. P. 3247, 1899, abst. Arms and Explo. 1899, **7**, 94; J. S. C. I. 1899, **18**, 526, 548, 707. F. P. 322946, abst. Mon. Sci. 1904, **61**, 16; Chem. Zts. 1903, **2**, 412.

- Delfino,¹ E. Blyth,² C. Claessen,³ G. Clark,⁴ C. Curtis and G. Andre,⁵ C. Curtis and A. Durnford,⁶ Cyanid-Ges. m. b. H.,⁷ A. Auchu,⁸ A. Broadbent and R. Woodbridge,⁹ F. du Pont,¹⁰ H. Dautriche,¹¹ C. Duttenhofer,¹² Deutsche Sprengstoff Act.-Ges.,¹³
1. E. P. 126687, 1917; abst. C. A. 1919, **13**, 2449; J. S. C. I. 1919, **38**, 514-A.
 2. E. P. 135813, 1919.
 3. U. S. P. 909546; abst. C. A. 1909, **3**, 1088; Mon. Sci. 1911, **75**, 107; Zts. Schiess. Spreng. 1909, **4**, 104. U. S. P. 914113; abst. C. A. 1909, **3**, 1461; Mon. Sci. 1910, **73**, 120. U. S. P. 1063469; abst. C. A. 1913, **7**, 2474; J. S. C. I. 1912, **31**, 713; Mon. Sci. 1914, **81**, 20; Chem. Ztg. Rep. 1913, **37**, 399. E. P. 20882, 1909; abst. J. S. C. I. 1911, **30**, 153. E. P. 21147, 1911; abst. C. A. 1913, **7**, 1100; J. S. C. I. 1912, **31**, 663; Chem. Ztg. Rep. 1912, **36**, 483; Zts. Schiess. Spreng. 1912, **7**, 420. F. P. 368344; abst. C. A. 1909, **3**, 119; Mon. Sci. 1908, **69**, 139. F. P. 434112; abst. J. S. C. I. 1912, **31**, 256; Mon. Sci. 1913, **79**, 186. D. R. P. 255903; abst. C. A. 1913, **7**, 1976; Chem. Zentr. 1913, **84**, I, 578; Chem. Ztg. Rep. 1912, **36**, 114; Wag. Jahr. 1913, **59**, I, 439; Zts. ang. Chem. 1913, **26**, 213; Zts. Schiess. Spreng. 1913, **8**, 99. D. R. P. 256572; abst. C. A. 1913, **7**, 1976; Chem. Zentr. 1913, **84**, I, 1080; Chem. Ztg. Rep. 1913, **37**, 114; Wag. Jahr. 1913, **59**, I, 439; Zts. ang. Chem. 1913, **26**, 213; Zts. Schiess. Spreng. 1913, **8**, 138. Dan. P. 9343, 1907. Ital. P. 119847, 1911; abst. Chem. Ztg. 1912, **36**, 1345.
 4. E. P. 3408, 1868; abst. Mon. Sci. 1870, **12**, 63; Deut. Industrietztg. 1870, 48; Wag. Jahr. 1870, **16**, 217.
 5. E. P. 11383, 1891; abst. J. S. C. I. 1891, **10**, 674, 740, 855; Chem. Centr. 1892, **63**, I, 112. E. P. 7978, 1892; abst. J. S. C. I. 1892, **11**, 481; 1893, **12**, 308, 374. E. P. 16595, 1899; abst. J. S. C. I. 1899, **18**, 888; 1900, **19**, 807, 851. E. P. 19773, 1900; abst. J. S. C. I. 1900, **19**, 1068; 1901, **20**, 1240; Mon. Sci. 1902, **58**, 166; Chem. Ztg. 1902, **26**, 254.
 6. E. P. 12591, 1899; abst. J. S. C. I. 1899, **18**, 636; 1900, **19**, 689.
 7. E. P. 27515, 1903; abst. J. S. C. I. 1905, **24**, 44; Wag. Jahr. 1905, **51**, I, 454. D. R. P. 201215; abst. C. A. 1909, **3**, 119; J. S. C. I. 1909, **28**, 162; Mon. Sci. 1912, **77**, 54; Chem. Zentr. 1908, **79**, II, 999; Chem. Ind. 1908, **31**, 591; Chem. Ztg. Rep. 1908, **32**, 510; Chem. Zts. 1908, **7**, 992; Jahr. Chem. 1905-8, II, 980; Wag. Jahr. 1908, **54**, 434; Zts. Schiess. Spreng. 1908, **3**, 374. D. R. P. 205762; abst. C. A. 1909, **3**, 1929; Chem. Zentr. 1909, **80**, I, 1131; Chem. Ind. 1909, **32**, 100; Chem. Ztg. Rep. 1909, **33**, 74; Jahr. Chem. 1909, II, 389; Wag. Jahr. 1909, **55**, II, 428; Zts. Schiess. Spreng. 1909, **4**, 109.
 8. E. P. 4128, 1908.
 9. Can. P. 198563, 1920; abst. C. A. 1920, **14**, 1610.
 10. U. S. P. 1341207; abst. C. A. 1920, **14**, 2265.
 11. Mem. poud. salp. 1906, **14**, 185; abst. C. A. 1909, **3**, 2053. Mem. poud. salp. **16**, I, 63, 58, 62, 72, 214, 217; **17**, 158, 173, 175; abst. C. A. 1912, **6**, 1227; 1913, **7**, 1418, 1417; 1914, **8**, 1208, 1207; Zts. Schiess. Spreng. 1912, **7**, 77. See also Zts. Schiess. Spreng. 1908, **3**, 251; abst. J. S. C. I. 1908, **27**, 783.
 12. E. P. 24782, 1904; abst. J. S. C. I. 1905, **24**, 105; Mon. Sci. 1907, **67**, 107. E. P. 19408, 1906; abst. C. A. 1907, **1**, 2835; J. S. C. I. 1907, **26**, 1029; Mon. Sci. 1911, **75**, 158; Zts. Schiess. Spreng. 1907, **2**, 436. E. P. 791, 1907; abst. C. A. 1907, **1**, 2506; J. S. C. I. 1907, **26**, 840; Mon. Sci. 1911, **75**, 158. F. P. 364413, additions 6620, 7749; abst. J. S. C. I. 1906, **25**, 911; 1907, **26**, 167, 1029, 1110; 1909, **28**, 384. See also F. Engel, E. P. 6022, 1887; abst. J. S. C. I. 1887, **6**, 398; 1888, **7**, 56; 1889, **8**, 818. F. Glaser, E. P. 17167, 1887; abst. J. S. C. I. 1888, **7**, 867.
 13. E. P. 2318, 1887; abst. J. S. C. I. 1887, **6**, 160, 850. D. R. P. 424520; abst. Mon. Sci. 1888, **32**, 1332; Ber. 1888, **21**, 334; Wag. Jahr. 1888, **34**, 491. F. P. 172309; abst. Mon. Sci. 1886, **28**, 843.

- C. Dittman,¹ W. Doering,² E. I. du Pont de Nemours Powder Co.,³
 • A. Frank,⁴ A. Girard,⁵ W. Greaves and E. Hann,⁶ G. Gariboldi,⁷ R.
 Hannan and E. Mills,⁸ A. Hargreaves and Curtis & Harvey,
 Ltd.,⁹ T. Hawkins,¹⁰ J. Bloom,¹¹ C. Henning,¹² C. Hengst,¹³ C.
 Herlin,¹⁴ L. Heuschen,¹⁵ M. Himalaya,¹⁶ International Powder
 Co.,¹⁷ F. Jones,¹⁸ J. Falkenstein and A. Böhm,¹⁹ W. Kirsanow,²⁰
1. E. P. 3458, 1867.
 2. Industries, 1889, **3**; Dingl. Poly. 1889, **273**, 67; abst. Chem. Tech. Rep. 1889, **28**, II, 171.
 3. F. Sparre, U. S. P. 850266, 1907; abst. C. A. 1907, **1**, 1786, 1773, Mon. Sci. 1907, **67**, 160; Zts. Schiess. Spreng. 1907, **2**, 436. U. S. P. 852143, 1907; abst. C. A. 1907, **1**, 2034, 2041; Mon. Sci. 1907, **57**, 160, Chem. Ztg. Rep. 1907, **31**, 267; Zts. Schiess. Spreng. 1907, **2**, 437. E. du Pont, U. S. P. 976211, 1910; abst. C. A. 1911, **5**, 786; Chem. Ztg. Rep. 1911, **35**, 85, Zts. Schiess. Spreng. 1911, **6**, 276. W. Swint, U. S. P. 1307766, 1919; abst. C. A. 1919, **13**, 2280; J. S. C. I. 1919, **38**, 604-A. E. P. 4099, 1911; abst. J. S. C. I. 1911, **30**, 836; Zts. Schiess. Spreng. 1912, **7**, 17.
 4. U. S. P. 792512, 1905; abst. J. A. C. S. 1906, **28R**, 76.
 5. E. P. 6045, 1905; abst. J. S. C. I. 1905, **24**, 1190; Mon. Sci. 1907, **67**, 107; 1910, **72**, 639; Chem. Ztg. Rep. 1906, **30**, 266; Zts. Schiess. Spreng. 1906, **1**, 50.
 6. E. P. 24847, 1895; abst. J. S. C. I. 1896, **15**, 68, 942; 1897, **16**, 65; Mon. Sci. 1897, **50**, 168; 1898, **52**, 95; Chem. Ztg. 1897, **26**, 449.
 7. Giorn. chim. ind. 1920, **2**, 10; abst. C. A. 1920, **14**, 1440.
 8. E. P. 5323, 1882; abst. J. S. C. I. 1882, **1**, 470; Wag. Jahr. 1884, **30**, 380. See also O. Guttman, report on progress of explosives industries, Dingl. Poly. 1890, **275**, 111; **278**, 19, 418; Jahr. Chem. 1890, **43**, 2704.
 9. E. P. 24235, 1894; abst. J. S. C. I. 1894, **13**, 1248; 1895, **14**, 912, 988. E. P. 15351, 1896; abst. J. S. C. I. 1896, **15**, 376; 1897, **16**, 488, 560. E. P. 4028, 1904; abst. J. S. C. I. 1905, **24**, 105. E. P. 6353, 1904; abst. J. S. C. I. 1905, **24**, 105.
 10. U. S. P. 1202712; abst. C. A. 1917, **11**, 100; J. S. C. I. 1916, **35**, 1237; Mon. Sci. 1917, **84**, 61.
 11. U. S. P. 1333701; abst. C. A. 1920, **14**, 1441.
 12. U. S. P. 1336463, 1920; abst. C. A. 1920, **14**, 1758.
 13. E. P. 15141, 1901; abst. J. S. C. I. 1902, **21**, 1155; Chem. Ztg. Rep. 1902, **26**, 1161.
 14. E. P. 26493, 1913; abst. J. S. C. I. 1915, **34**, 153; Chem. Ztg. Rep. 1915, **39**, 272. F. P. 465771, 1913; abst. J. S. C. I. 1914, **33**, 614.
 15. E. P. 1024, 1884; abst. J. S. C. I. 1884, **37**, 498.
 16. E. P. 4439, 1907; abst. C. A. 1908, **2**, 2622; J. S. C. I. 1908, **27**, 297. F. P. 374932, 1907; abst. J. S. C. I. 1907, **26**, 840; 1908, **27**, 184, 297.
 17. E. P. 12768, 1895; abst. Arms and Explo. 1895, **4**, 11; J. S. C. I. 1895, **14**, 712, 788, 820; Mon. Sci. 1896.
 18. E. P. 18161, 1901; abst. J. S. C. I. 1902, **21**, 1097; Mon. Sci. 1904, **61**, 64; Chem. Ztg. 1903, **27**, 40.
 19. E. P. 7238, 1892; abst. J. S. C. I. 1893, **12**, 547; Chem. Ztg. 1893, **17**, 1417; Chem. Tech. Rep. 1893, **32**, II, 272. D. R. P. 70067; abst. Zts. ang. Chem. 1893, **6**, 465; Chem. Centr. 1893, **64**, II, 1015; Chem. Ztg. 1894, **18**, 1089; Chem. Tech. Rep. 1893, **32**, II, 272; Wag. Jahr. 1893, **39**, 426; Ber. 1893, **28**, 958; Jahr. organ. Chem. 1893, **1**, 262; Tech. Chem. Jahr. 1893-4, **16**, 165; Meyer Jahr. Chem. 1893, **3**, 366. F. P. 220894; abst. Mon. Sci. 1893, **42**, 20; 1895, **45**, 143; Jahr. Chem. 1893, **46**, 889.
 20. E. P. 6159, 1901; abst. J. S. C. I. 1902, **21**, 561.

A. Kranz,¹ A. Cocking and Kynoch, Ltd.,² J. Lewin,³ M. Leonard,⁴ J. Luciani,⁵ C. Lundholm and Nobel's Explosives Co.,⁶ C. Lundholm and J. Sayers,⁷ J. Macnab and R. Jenkins,⁸ F. Matthews, E. Strange and H. Bliss,⁹ J. Mire,¹⁰ G. Lunt,¹¹ H. Maxim,¹² G. McRoberts,¹³ D. Metcalfe, A. Percy and Curtis & Harvey,¹⁴

1. U. S. P. 506784, 1893, abst. J. A. C. S. 1893, **15**, 595, Can. P. 45208, 1894.
2. U. S. P. 903958, abst. C. A. 1909, **3**, 717; J. S. C. I. 1908, **27**, 1223; Mon. Sci. 1911, **75**, 107; Chem. Ztg. Rep. 1909, **33**, 74; Zts. Schiess. Spreng. 1909, **4**, 137. E. P. 15564, 1905; abst. J. S. C. I. 1906, **25**, 497; Chem. Ztg. 1906, **30**, 487, Zts. Schiess. Spreng. 1906, **1**, 262. E. P. 22311, 1911; abst. C. A. 1913, **7**, 1101; J. S. C. I. 1912, **31**, 1095, Chem. Ztg. Rep. 1913, **37**, 193 E. P. 110237; abst. C. A. 1918, **12**, 428, J. S. C. I. 1917, **36**, 1248.
3. E. P. 4943, 1880, abst. Chem. Ind. 1882, **4**, 65, 180. D. R. P. 42893; abst. Chem. Centr. 1888, **59**, 1018; Wag. Jahr. 1888, **34**, 492, Chem. Tech. Jahr. 1887, **10**, 195, 1888, **11**, 184.
4. U. S. P. 507279, 1893, abst. J. A. C. S. 1893, **15**, 595, Mon. Sci. 1894, **42**, 24. E. P. 20066, 1893, abst. J. S. C. I. 1893, **12**, 973, 1094, 1894, **13**, 61.
5. E. P. 326037, and addition Oct. 31, 1902, abst. J. S. C. I. 1903, **22**, 760, 923, Mon. Sci. 1904, **61**, 16, Chem. Zts. 1903, **2**, 412, 543. E. P. 386966, 1907, abst. C. A. 1909, **3**, 1690, J. S. C. I. 1908, **27**, 837, Mon. Sci. 1909, **71**, 11.
6. U. S. P. 701591; abst. J. A. C. S. 1902, **24**, 544, J. S. C. I. 1902, **21**, 927; Mon. Sci. 1903, **59**, 6, Chem. Ztg. 1902, **26**, 588. E. P. 14231, 1901, abst. J. S. C. I. 1902, **21**, 1039. E. P. 19438, 1903, abst. J. S. C. I. 1904, **23**, 836; Chem. Ztg. 1905, **29**, 39.
7. E. P. 6399, 1889; abst. J. S. C. I. 1890, **9**, 414, Dingl. Poly. 1890, **278**, 20, Tech. Chem. Jahr. 1890, **13**, 153. E. P. 10376, 1889, abst. J. S. C. I. 1890, **9**, 764; Mon. Sci. 1911, **74**, 158. E. P. 13486, 1889, abst. J. S. C. I. 1890, **9**, 803. D. R. P. 53296, abst. Mon. Sci. 1905, **62**, 89, Ber. 1891, **24**, 182, Chem. Centr. 1891, **62**, I, 617, Tech. Chem. Jahr. 1890, **13**, 162, Wag. Jahr. 1890, **36**, 540, Zts. ang. Chem. 1890, **3**, 556. D. R. P. 55650, abst. Mon. Sci. 1891, **38**, 655, Ber. 1891, **24**, 429, Wag. Jahr. 1891, **37**, 428; Zts. ang. Chem. 1891, **4**, 169. Ital. P. 32809, 1892.
8. E. P. 1341, 1881. D. R. P. 42743, abst. Ber. 1888, **21**, 380, Wag. Jahr. 1888, **34**, 502, Tech. Chem. Jahr. 1887, **10**, 199, 1888, **11**, 186.
9. E. P. 12770, 1912, abst. C. A. 1913, **7**, 3842, J. S. C. I. 1913, **32**, 712.
10. U. S. P. 1128471, abst. C. A. 1915, **9**, 1118, Mon. Sci. 1915, **82**, 52, Chem. Ztg. Rep. 1916, **40**, 118.
11. E. P. 139488, 1920.
12. U. S. P. 434049, 1890. U. S. P. 974900, abst. C. A. 1911, **5**, 786; J. S. C. I. 1910, **29**, 1412, C. A. 1911, **5**, 786, Mon. Sci. 1911, **75**, 107, Chem. Ztg. Rep. 1911, **35**, 16, Zts. Schiess. Spreng. 1911, **6**, 136; 1912, **7**, 187. U. S. P. 1015814, 1912, abst. C. A. 1912, **6**, 805, J. S. C. I. 1912, **31**, 358, Chem. Ztg. Rep. 1912, **36**, 294. E. P. 4477, 1889, abst. J. S. C. I. 1889, **8**, 238; 1890, **9**, 238, 326. E. P. 18682, 1894; abst. J. S. C. I. 1894, **13**, 1010, 1129, 1219; 1897, **16**, 408. E. P. 16311, 1895; abst. J. S. C. I. 1895, **14**, 846; 1896, **15**, 942; 1898, **17**, 375. E. P. 15499, 1897, abst. J. S. C. I. 1897, **16**, 656, 716, 760. E. P. 2039, 1910, abst. C. A. 1911, **5**, 2952, J. S. C. I. 1910, **29**, 1476. D. R. P. 81805; abst. Ber. 1895, **28**, 827-R; Chem. Ztg. 1895, **19**, 1387, Jahr. Chem. 1895, **48**, 1361, Wag. Jahr. 1895, **41**, 463; Zts. ang. Chem. 1895, **8**, 386. H. Maxim and R. Schuppheus. U. S. P. 640213. See Engng. 1897, **64**, 235, 536; 1898, **65**, 739.
13. E. P. 1090, 1879; abst. J. A. C. S. 1880, **2**, 142, Ber. 1880, **13**, 585;

A. Mikolajczak,¹ J. Anders,² D. Mendeleeff,³ L. Monni,⁴ A. Muller,⁵ Jacobs,⁶ F. Nathan and W. Rintoul,⁶ J. Nathurst,⁷ Nitroglycerin Aktieb.,⁸ A. Nobel,⁹ K. Ohno,¹⁰ A. Pearcy and Curtis & Harvey,¹¹

Chem. Ind. 1880, **3**, 148

14. E. P. 13138, 1914; abst. C. A. 1915, **9**, 3130, J. S. C. I. 1915, **34**, 576; Mon. Sci. 1918, **85**, 23

1. U. S. P. 910936; abst. C. A. 1909, **3**, 1088, Mon. Sci. 1911, **75**, 107, U. S. P. 948790; abst. C. A. 1910, **4**, 1103, Mon. Sci. 1910, **73**, 120, Chem. Ztg. Rep. 1910, **34**, 143. F. P. 341911, abst. J. S. C. I. 1904, **23**, 911, Mon. Sci. 1905, **63**, 86; Chem. Zts. 1904, **3**, 668, 1905, **4**, 175

2. E. P. 800, 804, 1881, abst. J. A. C. S. 1882, **4**, 48, Wag. Jahr. 1881, **27**, 331; Chem. Ind. 1881, **4**, 140, 384; Ber. 1881, **14**, 2318; Jahr. reine Chem. 1881, **9**, 136, Chem. Tech. Rep. 1881, **20**, 11, 136. This explosive was called "Diaspongelatine."

3. U. S. P. 437499, 440921, 1890; abst. J. A. C. S. 1890, **12**, 416, 478

4. Inter. Cong. Appl. Chem. 1907, III, 565, abst. Frankl. Inst. 1909, **167**, 111; Chem. Centr. 1906, **77**, 14, 1887, Jahr. Chem. 1905-8, II, 980, 1909, **62**, II, 389; Zts. Schiess. Spreng. 1906, **1**, 305.

5. F. P. 348807, abst. Mon. Sci. 1906, **65**, 60, Chem. Zts. 1905, **4**, 184.

6. U. S. P. 1280278, 1280279, 1918, abst. C. A. 1918, **12**, 2686, 2689; J. S. C. I. 1918, **37**, 284-A, 784-A; Mon. Sci. 1919, **86**, 30. U. S. P. 1302202; abst. C. A. 1919, **13**, 1930. N. Zeal. P. 34752, 1914.

7. U. S. P. 1005739, 1911, abst. C. A. 1912, **6**, 154, J. S. C. I. 1911, **30**, 1281; Mon. Sci. 1912, **77**, 159, Zts. Schiess. Spreng. 1912, **7**, 33.

8. Swed. P. 40296, 1916, abst. C. A. 1916, **10**, 1597.

9. U. S. P. 175735, 1876. E. P. 226, 1879; abst. J. A. C. S. 1880, **2**, 143, Wag. Jahr. 1880, **26**, 372. E. P. 2399, 1879, abst. J. A. C. S. 1880, **2**, 299. E. P. 1470, 1471, 1888, abst. J. S. C. I. 1888, **7**, 160; 1889, **8**, 78, 133, 214; 1890, **9**, 326, 414, 764, 1893, **12**, 296; Jahr. Chem. 1889, **42**, 2682, Wag. Jahr. 1889, **35**, 474. E. P. 1988, 1889, abst. J. S. C. I. 1889, **8**, 160, 1890, **9**, 326. E. P. 4479, 1889, abst. J. S. C. I. 1889, **8**, 238, 1890, **9**, 238, 326, 414. E. P. 9361, 1889; abst. J. S. C. I. 1889, **8**, 500, 1890, **9**, 326, 580, 764; 1893, **12**, 290. E. P. 27197, 1896, abst. J. S. C. I. 1896, **15**, 942; 1897, **16**, 1064; 1898, **17**, 182. D. R. P. 36872, abst. Wag. Jahr. 1886, **32**, 319, Chem. Ind. 1886, **9**, 269, 362, Industriell. 1887, 47, Chem. Tech. Rep. 1886, **25**, II, 297; Ber. 1886, **19**, 800, Jahr. Chem. 1886, **49**, 2078; Dingl. Poly. 1880, **273**, 67; 1890, **275**, 115. D. R. P. 45712, abst. Ber. 1889, **22**, 40-R, Wag. Jahr. 1888, **34**, 502, Chem. Ind. 1889, **12**, 65, Chem. Tech. Rep. 1888, **27**, II, 225; Tech. Chem. Jahr. 1888, **11**, 187. D. R. P. 51471; abst. Jahr. Chem. 1890, **43**, 2708; Chem. Ztg. 1890, **14**, 670, 1892, **16**, 1278; Chem. Tech. Rep. 1890, **29**, I, 223, Chem. Ind. 1890, **36**, 541, Ber. 1890, **23**, 528-R, Mon. Sci. 1891, **37**, 426; 1905, **62**, 87, Meyer Jahr. Chem. 1891, **1**, 333, Tech. Chem. Jahr. 1889, **12**, 168, 1892, **15**, 175. D. R. P. 97690, abst. Mon. Sci. 1898, **52**, 266, Chem. Centr. 1898, **69**, II, 687; Chem. Ztg. 1898, **22**, 565, Wag. Jahr. 1898, **44**, 376, Zts. ang. Chem. 1898, **11**, 676. Can. P. 37433, 1891. See also, Mining J. 1881, **51**, 909. In this connection see also Nobel's Explosives Co., E. P. 26239, 1900, abst. C. A. 1911, **5**, 3158, J. S. C. I. 1911, **30**, 385. E. P. 8769, 1910; abst. C. A. 1911, **5**, 2952, J. S. C. I. 1911, **30**, 110; Mon. Sci. 1915, **82**, 77, Chem. Ztg. Rep. 1911, **35**, 550, Zts. Schiess. Spreng. 1911, **6**, 57, 216. Norw. P. 20858, 1916, Holl. P. 1218, 1916, abst. C. A. 1916, **10**, 1711, 1932. See also Dynamit Actien Ges. vorm. A. Nobel & Co., E. P. 14825, 1903, abst. J. S. C. I. 1904, **23**, 799; Mon. Sci. 1905, **63**, 68, Chem. Ztg. 1904, **28**, 1074. D. R. P. 4829, 1878; abst. Zts. Chem. Grossgewerbe 1879, **4**, 288, Chem. Ind. 1879, **2**, 171, Chem. Ztg. 1879, **3**, 197; Chem. Tech. Rep. 1879, **18**, I, 288; Dingl. Poly. 1879, **232**, 486; D. R. P. 182030, 1903; abst. Zts. ang. Chem. 1907, **20**, 1195, Chem. Zentr. 1907, **78**,

- ¹ K. Pflug, ¹ C. van Pittius, ² Powerite Explosive Co., ³ H. Prod-homme, ⁴ W. Rintoul, D. Peacock and Nobel's Explosives Co., Ltd., ⁵ W. Reunert, ⁶ D. Robertson and M. Wollenweber, ⁷ F. Nathan, W. Rintoul and F. Baker, ⁸ F. Titschke, ⁹ A. Rollason, ¹⁰ J. Russell, ¹¹ E. Ryves, ¹² P. Sanford, ¹³ J. Sayers, W. Wilson and J. Thorburn, ¹⁴ F. Schachtebeck, ¹⁵ H. Schoeneweg, ¹⁶ O. Silberrad, ¹⁷ II, 199; *Jahr. Chem.* 1905-8, II, 303; *Chem. Ind.* 1907, **30**, 161; *Zts. Schiess. Spreng.* 1907, **2**, 134. F. P. 333443, 1903; abst. J. S. C. I. 1903, **22**, 1367; *Mon. Sci.* 1905, **63**, 85; *Chem. Zts.* 1904, **3**, 151. Consult also *Dynamite Nobel Soc. Anon. (Italy)* F. P. 21529, 1905; abst. J. S. C. I. 1906, **25**, 119; *Zts. Schiess. Spreng.* 1907, **2**, 12, 36. F. P. 360787, 1905; abst. C. A. 1907, **1**, 1649, 1623; *Mon. Sci.* 1907, **67**, 41. M. Abelli, U. S. P. 899855, 1908; abst. C. A. 1909, **3**, 377; *Mon. Sci.* 1909, **71**, 128; *Zts. Schiess. Spreng.* 1909, **4**, 35. For composition of *Dynobel* No. 3, and 4, see Home Office Order No. 239, Apr. 14, 1916; abst. J. S. C. I. 1916, **35**, 655.
10. E. P. 16978, 1913; abst. C. A. 1915, **9**, 380; J. S. C. I. 1914, **33**, 614.
 11. E. P. 7647, 1914; abst. C. A. 1915, **9**, 2593; J. S. C. I. 1915, **34**, 101.
 101. E. P. 17656, 1914; abst. J. S. C. I. 1915, **34**, 101.
 1. D. R. P. 125098; abst. *Chem. Centr.* 1901, **72**, II, 1140; *Chem. Ztg.* 1901, **25**, 1019; *Chem. Zts.* 1902, **1**, 255; *Jahr. Chem.* 1901, **54**, 896; *Wag. Jahr.* 1901, **47**, I, 490; *Zts. ang. Chem.* 1901, **14**, 1213.
 2. E. P. 555, 1910; abst. C. A. 1911, **5**, 2952; J. S. C. I. 1911, **30**, 156; *Chem. Ztg. Rep.* 1911, **35**, 379. E. P. 25274, 1910; abst. C. A. 1912, **6**, 1527; J. S. C. I. 1911, **30**, 1281. F. P. 424555, 1911; abst. *Mon. Sci.* 1913, **79**, 27. See also 6th Inter. Cong. Appl. Chem. 1907, **2**, 553; abst. J. S. C. I. 1908, **27**, 247.
 3. E. P. 19267, 1914; abst. J. S. C. I. 1915, **34**, 890. E. P. 16505, 1915; abst. C. A. 1917, **11**, 1549; J. S. C. I. 1916, **35**, 656.
 4. E. P. 4200, 1880; abst. J. A. C. S. 1882, **4**, 99, 180, 384.
 5. U. S. P. 1303115; abst. C. A. 1919, **13**, 1930. E. P. 16692, 1914; abst. J. S. C. I. 1915, **34**, 688; *Mon. Sci.* 1917, **84**, 80. E. P. 14655, 14656, 1915; abst. J. S. C. I. 1919, **38**, 340-A.
 6. D. R. P. 16254; abst. *Chem. Ind.* 1882, **5**, 9; *Industriell.* 1882, 54; *Chem. Tech. Rep.* 1882, **21**, II, 136; J. S. C. I. 1882, **1**, 75.
 7. E. P. 10062, 1912; abst. C. A. 1913, **7**, 3542; J. S. C. I. 1913, **32**, 712; *Zts. Schiess. Spreng.* 1913, **8**, 476.
 8. U. S. P. 1338691, 1920.
 9. U. S. P. 1063469; abst. C. A. 1913, **7**, 2474; *Mon. Sci.* 1914, **61**, 20; *Chem. Ztg. Rep.* 1913, **37**, 399; *Zts. Schiess. Spreng.* 1913, **8**, 319. F. P. 434112; abst. J. S. C. I. 1912, **31**, 258.
 10. E. P. 3301, 1866.
 11. E. P. 28710, 1903; abst. J. S. C. I. 1904, **23**, 1238; *Mon. Sci.* 1906, **65**, 29; *Chem. Ztg.* 1905, **29**, 495.
 12. E. P. 298, 1891; abst. J. S. C. I. 1891, **10**, 86, 972; 1892, **11**, 180; *Mon. Sci.* 1892, **40**, 166.
 13. J. A. C. S. 1893, **15**, 552; abst. J. S. C. I. 1893, **12**, 620; *Jahr. Chem.* 1893, **46**, 887.
 14. U. S. P. 995187, 995373, 1911; abst. C. A. 1911, **5**, 2724, 2725; *Mon. Sci.* 1912, **77**, 32; *Chem. Ztg. Rep.* 1911, **35**, 642.
 15. E. P. 22645, 1902; abst. J. S. C. I. 1903, **22**, 229; *Mon. Sci.* 1905, **63**, 14; *Chem. Ztg.* 1904, **28**, 218.
 16. E. P. 1591, 1888; abst. J. S. C. I. 1888, **7**, 160.
 17. U. S. P. 849025; abst. C. A. 1907, **1**, 1773, 1785; *Mon. Sci.* 1907, **67**, 160; *Zts. Schiess. Spreng.* 1907, **2**, 436. U. S. P. 850119; abst. C. A. 1907, **1**, 1773, 1785; *Mon. Sci.* 1907, **67**, 160; *Zts. Schiess. Spreng.* 1908, **3**,

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18. E. P. 18692, 1905, abst. Mon. Sci. 1907, **67**, 164; Chem. Ztg. Rep. 1907, **31**, 28; Zts. Schiess. Spreng. 1907, **2**, 176. E. P. 13560, 1912, abst. Zts. Schiess. Spreng. 1913, **8**, 117. E. P. 19381, 1912, abst. J. S. C. I. 1913, **32**, 843; C. A. 1913, **7**, 574. E. P. 380108, abst. C. A. 1909, **3**, 1689; Mon. Sci. 1909, **71**, 10.

1. F. P. 183828, 1887, abst. Mon. Sci. 1888, **31**, 376.

2. E. P. 20069, 1896, abst. Chem. Ztg. Rep. 1898, **22**, 106.

3. See Mem. pond. salp. **11**, 49, abst. Wag. Jahr. 1902, **48**, I, 368; Zts. ang. Chem. 1902, **15**, 155. Cf. Mem. pond. salp. **2**, 648.

4. E. P. 349992, 1904, abst. C. A. 1907, **1**, 1325, 1343; Mon. Sci. 1907, **67**, 9.

5. Swiss P. 57306.

6. Swiss P. 57773, 1911; E. P. 432863, 1910, abst. Mon. Sci. 1913, **79**, 28.

7. Swed. P. 34505, 35011, 1910, abst. C. A. 1914, **8**, 1673.

8. Zts. Schiess. Spreng. 1912, **7**, 129, abst. J. S. C. I. 1912, **31**, 410. U. S. P. 1194561, abst. C. A. 1916, **10**, 2525; J. S. C. I. 1916, **35**, 980; Mon. Sci. 1917, **84**, 61. E. P. 14004, 1914, abst. C. A. 1915, **9**, 3363; J. S. C. I. 1915, **34**, 819. F. P. 473264, abst. J. S. C. I. 1915, **34**, 576. D. R. P. 291578; abst. C. A. 1917, **11**, 889; J. S. C. I. 1916, **35**, 1181; Chem. Zentr. 1916, **87**, I, 958; Chem. Ztg. Rep. 1916, **40**, 194; Wag. Jahr. 1916, **62**, I, 254; Zts. ang. Chem. 1916, **29**, 443.

9. Atti R. Accad. Lincei, 1918, **27**, II, 52, abst. J. S. C. I. 1918, **37**, 749-A.

10. U. S. P. 625908, 1899. E. P. 12760, 1898, abst. J. S. C. I. 1898, **17**, 632; 1899, **18**, 326, 400; Mon. Sci. 1900, **56**, 65. D. R. P. 117051, abst. Chem. Zentr. 1901, **72**, I, 212; Chem. Ztg. 1901, **25**, 30; Wag. Jahr. 1901, **47**, I, 486; Zts. ang. Chem. 1900, **13**, 118.

11. U. S. P. 648222, 1900; abst. Mon. Sci. 1900, **56**, 191. E. P. 7583, 1900, abst. J. S. C. I. 1900, **19**, 491, 586, 689.

12. U. S. P. 1307766, 1919, abst. C. A. 1919, **13**, 2280; J. S. C. I. 1919, **38**, 604-A.

13. E. P. 18241, 1888, abst. J. S. C. I. 1888, **7**, 884, 1889, **8**, 852, 1010. E. P. 18472, 1890, abst. J. S. C. I. 1890, **9**, 1090, 1891, **10**, 880, 949; Chem. Zentr. 1892, **63**, I, 358.

14. E. P. 9791, 1906; abst. C. A. 1907, **1**, 2181, 2193; J. S. C. I. 1907, **26**, 640; Mon. Sci. 1910, **72**, 728; Zts. Schiess. Spreng. 1907, **2**, 374. E. P. 18279, 1909; abst. C. A. 1911, **5**, 993; J. S. C. I. 1910, **29**, 650. F. P. 405822; abst. Mon. Sci. 1912, **77**, 175. D. R. P. 226422, abst. C. A. 1914, **5**, 1195; Chem. Zentr. 1910, **81**, II, 1264; Chem. Ztg. Rep. 1910, **34**, 521; Jahr. Chem. 1910, **63**, II, 426; Wag. Jahr. 1910, **56**, I, 490; Zts. Schiess. Spreng. 1910, **5**, 442. Dan. P. 10034, 1907. Swiss P. 48474, 1909; 50836, 1910. See also Zts. Schiess. Spreng. 1907, **2**, 21; abst. Chem. Zentr. 1907, **78**, I, 1001. Cf. W. Wendin, Chem. Tech. Eng. and Min. J. Feb. 25, 1888.

15. E. P. 17205, 1913; abst. C. A. 1915, **9**, 381; J. S. C. I. 1914, **33**, 943. F. P. 470765; abst. J. S. C. I. 1915, **34**, 199; Mon. Sci. 1916, **83**, 693. Can. P. 166035, 1915; abst. C. A. 1916, **10**, 1090.

16. Mitth. Genest. Artill. u. Geniewesen, 1887, 656, abst. Wag. Jahr.

R. Weyel,¹ Westfälisch-Anhaltische Sprengstoff Akt.-Ges.,² J. Wilson,³ and others.⁴

In addition to nitroglycerol, many other organic bodies have been proposed and used in combination for explosive purposes. Among the more important which have been applied for this purpose from time to time are included nitrohydrocarbons⁵ as nitrobenzene,⁶ the dinitrobenzene combinations of W. Orsman,⁷ and of G. Trench;⁸ trinitrobenzene (benzite),⁹ dinitrophenol,¹⁰ dinitromonochlorhydrin,¹¹ nitronaphthalin,¹² methyl-

17. U. S. P. 398559, 1889; abst. Proc. U. S. Nav. Inst. 1889, **15**, 501.
18. F. P. 458372, 1913; abst. C. A. 1914, **8**, 2807; J. S. C. I. 1913, **32**, 1088; Mon. Sci. 1914, **81**, 128; Chem. Ztg. Rep. 1914, **38**, 300.
1. E. P. 21240, 1906; abst. C. A. 1907, **1**, 1195; J. S. C. I. 1907, **26**, 167; Mon. Sci. 1909, **71**, 76; Chem. Ztg. Rep. 1908, **32**, 186.
2. E. P. 17891, 1906; abst. C. A. 1907, **1**, 908, 943; J. S. C. I. 1906, **25**, 1119; Zts. Schiess. Spreng. 1907, **2**, 50. See also E. P. 25884, 1901; abst. Arms and Explo. 1903, **11**, 16; J. S. C. I. 1902, **21**, 1471. E. P. 26617, 1901; abst. J. S. C. I. 1902, **21**, 1471. E. P. 3334, 1902; abst. Arms and Explo. 1903, **11**, 48; J. S. C. I. 1903, **22**, 229; Mon. Sci. 1904, **61**, 63; Chem. Ztg. 1903, **27**, 600. E. P. 13531, 1903; abst. J. S. C. I. 1904, **23**, 560. E. P. 352750; abst. J. S. C. I. 1905, **24**, 961, 987, 1084; 1906, **25**, 393. F. P. 370132; abst. C. A. 1909, **3**, 249; J. S. C. I. 1907, **26**, 280; Mon. Sci. 1908, **69**, 139. D. R. P. 203190; abst. J. S. C. I. 1908, **27**, 1178; Chem. Zentr. 1908, **79**, II, 1842; Chem. Ind. 1908, **31**, 717; Chem. Ztg. Rep. 1908, **32**, 624; Wag. Jahr. 1908, **54**, I, 437; Zts. ang. Chem. 1908, **21**, 2377; Zts. Schiess. Spreng. 1908, **3**, 417. Aust. P. 35955, 1908.
3. E. P. 8769, 1910; abst. J. S. C. I. 1911, **30**, 110.
4. In this connection see also Arms and Explo. 1893, **2**, 30. Mem. poud. salp. **11**, 51; abst. J. S. C. I. 1902, **21**, 425. Chem. Trade J. No 1311 of Aug. 29, 1914; abst. J. S. C. I. 1914, **33**, 986. For Brazilian Smokeless Powder see Engineering (London), Aug. 18, 1911.
5. W. Eberlein, D. R. P. 260604, 1911; abst. C. A. 1913, **7**, 3230; J. S. C. I. 1913, **32**, 843; Chem. Zentr. 1913, **84**, II, 111; Chem. Ztg. Rep. 1913, **37**, 336; Wag. Jahr 1913, **59**, I, 439; Zts. ang. Chem. 1913, **26**, II, 448; Zts. Schiess. Spreng. 1913, **8**, 236. Cf. S. von Romoki, D. R. P. 99875; abst. Chem. Centr. 1899, **70**, I, 359; Chem. Ztg. 1898, **22**, 1029; Wag. Jahr. 1898, **44**, 373; Zts. ang. Chem. 1898, **11**, 1022.
6. E. Turpin, E. P. 4310, 1888; abst. J. S. C. I. 1888, **7**, 364, 884; 1889, **8**, 61. M. Lindsley, U. S. P. 1008725, 1911; abst. C. A. 1912, **6**, 294; Mon. Sci. 1912, **77**, 159; Zts. Schiess. Spreng. 1912, **7**, 81.
7. E. P. 29598, 1896; abst. Arms and Explo. 1898, **6**, 66; Mon. Sci. 1898, **52**, 223; Chem. Ztg. 1898, **22**, 445.
8. E. P. 18241, 1888; abst. J. S. C. I. 1888, **7**, 884; 1889, **8**, 852, 1010. The smokeless powder known as Riffite contains dinitrobenzene, see Arms and Explo. 1900, **8**, 19, 21, 50, 69, 82.
9. C. Volney, E. P. 25413, 1897; abst. J. S. C. I. 1897, **16**, 958, 1064; 1898, **17**, 70.
10. G. Hathaway, U. S. P. 815821, 1906; abst. J. A. C. S. 1906, **28**, 475; Mon. Sci. 1906, **65**, 121; Chem. Zts. 1906, **5**, 207; Zts. Schiess. Spreng. 1906, **1**, 231.
11. Westfälisch-Anhaltische Sprengstoff Akt.-Ges., E. P. 6361, 1905; abst. J. S. C. I. 1906, **25**, 393; Zts. Schiess. Spreng. 1906, **1**, 198.
12. A. Geserich, D. R. P. 93228; abst. Chem. Centr. 1897, **68**, II, 923;

naphthalenes,¹ nitromethylnaphthalene,² and chlorinated nitro-naphthalene.³

For waterproofing the nitrocellulose, the use of resin,⁴ paraffin,⁵ fat,⁶ glue,⁷ and carnauba and beeswax⁸ have been proposed. Other bodies which have been brought forward as useful combinations with nitrocellulose⁹ are acetin,⁹ sugar,¹⁰ nitro-sugar,¹¹ aniline,¹² trinitrobenzene alone or with rosaniline,¹³ China wood oil (tung oil),¹⁴ nitro cresol,¹⁵ trinitroanisole,¹⁶ trinitroamino-

Chem. Ztg. 1897, **21**, 672; Wag. Jahr. 1897, **43**, 482; Zts. ang. Chem. 1897 **10**, 641; Jahr. Chem. 1898, **51**, 1063

1. O. Silberrad, Swiss P. 63364, 1912
2. O. Silberrad, U. S. P. 1040793; abst. C. A. 1912, **6**, 3525; Mon. Sci. 1913, **79**, 13; Zts. Schiess. Spreng. 1913, **8**, 179. U. S. P. 1040794, abst. C. A. 1912, **6**, 3525; J. S. C. I. 1914, **33**, 504; Zts. Schiess. Spreng. 1913, **8**, 179. U. S. P. 1102964; abst. C. A. 1914, **8**, 3122; J. S. C. I. 1914, **33**, 845; Mon. Sci. 1914, **81**, 188. E. P. 13442, 1911; abst. C. A. 1912, **6**, 3525; J. S. C. I. 1912, **31**, 703; Chem. Ztg. Rep. 1912, **36**, 506. E. P. 13443, 1911, abst. C. A. 1912, **6**, 3525; J. S. C. I. 1912, **31**, 703; Chem. Ztg. Rep. 1912, **36**, 506. E. P. 13860, 13861, 1911, abst. C. A. 1913, **7**, 258; J. S. C. I. 1912, **31**, 978, 1009; Chem. Ztg. Rep. 1913, **37**, 36. E. P. 19381, 1912, abst. C. A. 1914, **8**, 576; J. S. C. I. 1913, **32**, 843. E. P. 380108, abst. C. A. 1909, **3**, 1689; Mon. Sci. 1909, **71**, 10. Swiss P. 63334, 1912
3. W. Pierce, E. P. 22240, 1912, abst. C. A. 1914, **8**, 1014; J. S. C. I. 1913, **32**, 1171; Chem. Ztg. Rep. 1914, **38**, 211.
4. H. Maxim, E. P. 10071, 1899, abst. Arms and Explo. 1900, **8**, 85
5. Muencke, D. R. P. 690, abst. Chem. Ind. 1878, **1**, 127; Wag. Jahr. 1878, **24**, 466, 467. E. Prentice, E. P. 2768, 1877, abst. Wag. Jahr. 1878, **24**, 466; Chem. Ind. 1878, **1**, 205; Zts. Chem. Grossgew. 1878, **3**, 680. (The number is given as 2468 in the abstracts.) See also E. P. 1129, 1867; abst. Zts. Chem. Grossgew. 1878, **3**, 680. W. Wolff and M. von Forster, E. P. 7640, 1885; abst. J. S. C. I. 1885, **4**, 467.
6. J. Schulhof, U. S. P. 304361, 1883, abst. J. A. C. S. 1884, **6**, 314.
7. F. Schaechtebeck, D. R. P. 172651; abst. Mon. Sci. 1908, **69**, 47; Chem. Centr. 1906, **77**, II, 840; Jahr. Chem. 1905-8, II, 303; Wag. Jahr. 1906, **52**, I, 476; Zts. ang. Chem. 1906, **19**, 1235; Zts. Schiess. Spreng. 1906, **1**, 239.
8. E. von Brauk, D. R. P. 54435, abst. Ber. 1891, **24**, 59; Chem. Tech. Rep. 1893, **32**, II, 275; Wag. Jahr. 1890, **36**, 543; Zts. ang. Chem. 1891, **4**, 34
9. V. Vender, U. S. P. 946294; abst. C. A. 1910, **4**, 671; Mon. Sci. 1910, **73**, 120; Chem. Ztg. Rep. 1910, **34**, 143. F. P. 372267; abst. C. A. 1909, **3**, 249; J. S. C. I. 1907, **26**, 553; Mon. Sci. 1908, **69**, 140; Chem. Ztg. Rep. 1907, **31**, 570.
10. R. Punshon, U. S. P. 124510, 1872.
11. H. Kolf, E. P. 8811, 1890; abst. J. S. C. I. 1890, **9**, 686; 1891, **10**, 404, 573; 1893, **12**, 1057. E. P. 22739, 1892; abst. J. S. C. I. 1892, **11**, 1050; 1893, **12**, 890, 1057. F. P. 206198; abst. Mon. Sci. 1891, **38**, 239.
12. C. Lundholm and G. Hosie, E. P. 7301, 1890; abst. J. S. C. I. 1890, **9**, 579; 1891, **10**, 292, 484.
13. C. Volney, U. S. P. 502895, 1897; abst. Chem. Ztg. 1897, **21**, 987.
14. C. Hunter, E. P. 17155, 1912; abst. C. A. 1914, **8**, 424; J. S. C. I. 1913, **32**, 843.
15. Franke, F. P. 179452, 1886; abst. Mon. Sci. 1887, **30**, 1143.
16. Hudson Maxim, U. S. P. 951445; abst. C. A. 1910, **4**, 1546; Mon. Sci. 1910, **73**, 120; Chem. Ztg. Rep. 1910, **34**, 171. U. S. P. 954900; abst.

anisol,¹ hexanitroethane,² tannogelatin,³ lead nitrate,⁴ ammonium humate (from peat),⁵ urea nitrate,⁶ diethyldiphenylurea,⁷ lead trinitroresorcinate,⁸ and the sodium salts of oxalic, tartaric and citric acids,⁹ together with *s*-dimethylethylene nitrate,¹⁰ and many other bodies.¹¹

C. A. 1911, **5**, 786; Mon. Sci. 1911, **75**, 107; Chem. Ztg. Rep. 1911, **35**, 16; Zts. Schiess. Spreng. 1911, **6**, 136; 1912, **7**, 187. F. P. 2039, 1910; abst. C. A. 1911, **5**, 2952; J. S. C. I. 1910, **29**, 1476. F. P. 412029; abst. Mon. Sci. 1911, **75**, 175.

1. B. Flirschheim, E. P. 18777, 1911; abst. C. A. 1913, **7**, 1100; J. S. C. I. 1912, **31**, 798; Chem. Ztg. Rep. 1913, **37**, 126.

2. C. Claessen, E. P. 24713, 1913; abst. J. S. C. I. 1915, **34**, 852. F. P. 24839, 1913; abst. J. S. C. I. 1914, **33**, 660. F. P. 410239, and addition 18487; abst. J. S. C. I. 1914, **33**, 614. F. P. 463714; abst. C. A. 1914, **8**, 3238; Mon. Sci. 1916, **83**, 67. Vereinigte Koln-Rottweiler Pulverfabriken, D. R. P. 277594, 1913; abst. Chem. Zentr. 1914, **85**, II, 743; Chem. Ztg. Rep. 1914, **38**, 489; Wag. Jahr. 1914, **60**, I, 360; Zts. ang. Chem. 1914, **27**, 580.

3. C. Curtis and G. Andre, E. P. 5821, 1891; abst. J. S. C. I. 1891, **10**, 404; 1892, **11**, 199, 456; 1893, **12**, 374.

4. J. de Macar, E. P. 10456, 1900; abst. J. S. C. I. 1900, **19**, 586; 1901, **20**, 617; Mon. Sci. 1902, **58**, 166; Chem. Ztg. 1901, **25**, 876.

5. F. Gaens, D. R. P. 48933, abst. Ber. 1889, **22**, 525-R; Chem. Centr. 1890, **61**, I, 560; Wag. Jahr. 1889, **35**, 473; Tech. Chem. Jahr. 1889, **12**, 163.

6. J. Karstairs, U. S. P. 625684, 1899; J. Wanklyn, E. P. 9799, 1888; abst. J. S. C. I. 1889, **8**, 818; Zts. ang. Chem. 1890, **3**, 217; Wag. Jahr. 1890, **36**, 545; Chem. Ind. 1890, **13**, 111; Tech. Chem. Jahr. 1890, **13**, 166; Chem. Tech. Rep. 1890, **29**, I, 223; Jahr. Chem. 1890, **43**, 2710.

7. C. Claessen, F. P. 368344, abst. C. A. 1909, **3**, 119; Mon. Sci. 1908, **69**, 139. For manufacture of urea see Badische Anilin & Sodafabrik, E. P. 145060, 1920. H. Immendorf and H. Kappen, D. R. P. 267227, 1911; D. R. P. Anm. I-12064, I-13247, I-13379, 1910; Hung. P. Appl. I-1338, 1911. Of bromideethylacetylurea, Farbenfabr. vorm. F. Bayer & Co., D. R. P. 243233, 1910.

8. W. Buell, U. S. P. 1312156; abst. C. A. 1919, **13**, 2599. Also P. Wangelmann, E. P. 139811, 1918.

9. H. Schöneweg, U. S. P. 371376, 1887; abst. J. A. C. S. 1887, **9**, 180. Westfälisch-Anhaltische Sprengstoff Akt.-Ges., D. R. P. 243845, 1906; abst. C. A. 1912, **6**, 2533.

10. F. Matthews, E. Strange and H. Bliss, E. P. 12770, 1912; abst. C. A. 1913, **7**, 3842; J. S. C. I. 1913, **32**, 712. F. P. 458309; abst. C. A. 1914, **8**, 2807; Mon. Sci. 1914, **81**, 128; Chem. Ztg. Rep. 1914, **38**, 299.

11. L. Edeleanu and G. Filiti, nitropetroleum and gun cotton, U. S. P. 745802, 1903; abst. J. S. C. I. 1904, **26R**, 316; Mon. Sci. 1904, **61**, 99; Chem. Zts. 1904, **3**, 279; Can. P. 84334, 1903. E. Thorn, nitrocellulose and hydrocarbon compounds, E. P. 15084, 1893. M. Jeschek and J. Jaresch, cellulose and nitric acid, D. R. P. 44041; abst. Ber. 1888, **21**, 868-R; Wag. Jahr. 1888, **34**, 493. J. Woods, artificial camphor, benzoline and gun cotton, E. P. 14328, 1897; abst. J. S. C. I. 1897, **16**, 582, 1898, **17**, 300; 487; Chem. Ztg. 1898, **22**, 964. A. Aubert, addition of pulverized cork to gelatinized explosives, Norw. P. 26835, 1916; abst. C. A. 1916, **10**, 1932. S. Adde, nitro aromatic hydrocarbons and nitrocellulose, Can. P. 190379, 1919. The Chem. Fabrik von Heyden A. G. employ furfural in place of acetone and other solvents for the gelatinization of cellulose nitrate; D. R. P. 302460; abst. Chem. Zentr. 1920, **91**, II, 468. F. Quarteri and E. Molinari, camphor and paraffin or ceresin, E. P. 19547, 1914.

Picric acid, either alone¹ or in combination, forms the essence of the inventions of A. Nobel,² E. Turpin,³ and J. Skoglund,⁴ while ammonium picrate either alone or combined with ammonium carbonate,⁵ potassium chlorate,⁶ or barium nitrate,⁷ but always in conjunction with nitrocellulose, has been used extensively for special purposes.⁸ As adjuncts, dinitrophenol, trinitrophenol,⁹ aromatic nitrohydrocarbons,¹⁰ dinitrobenzene¹¹ and mononitrophenol¹² have also been incorporated. Guanidine picrate¹³ has been patented for this purpose.

The nitro derivatives of toluene, xylene and cymene have recently been combined with nitrocellulose for a variety of important uses. As is well known, trinitrotoluene alone is an explosive of great stability and durability, but for military powder purposes it is not sufficiently dense, and would be more powerful if it contained a greater proportion of oxygen. However, the nitrotoluenes in combination with nitrocellulose have been found to possess many desirable properties, especially as a deterrent constituent in propellant powders.¹⁴

1. See Dingl. Poly. 1883, **249**, 456
2. D. R. P. 11030; abst. J. A. C. S. 1881, **3**, 71, Wag. Jahr. 1880, **26**, 379
3. E. P. 15089, 1885; abst. J. S. C. I. 1885, **4**, 762, 1886, **5**, 16, 679
4. E. P. 18362, 1888; abst. J. S. C. I. 1889, **8**, 160, 322, 478
5. S. Emmens, D. R. P. 54528, 1890; abst. Ber. 1891, **24**, 290 R, Tech. Chem. Jahr. 1890, **13**, 154; Jahr. Chem. 1890, **43**, 2708, Wag. Jahr. 1890, **36**, 545, Zts. ang. Chem. 1890, **3**, 714
6. A. Müller-Jacobs, U. S. P. 777125, 1904; abst. J. A. C. S. 1905, **27R**, 499; Mon. Sci. 1905, **63**, 142, Chem. Ztg. 1905, **29**, 11, Chem. Zts. 1905, **4**, 198.
7. C. Curtis and G. Andre, E. P. 9062, 1899; abst. Arms and Explo. 1900, **8**, 86; Mon. Sci. 1901, **57**, 148, Chem. Ztg. 1900, **24**, 759
8. S. Emmens, U. S. P. 423230, 1890; abst. J. A. C. S. 1890, **12**, 76
9. A. Nobel, E. P. 226, 1879; abst. J. A. C. S. 1880, **2**, 143, Wag. Jahr. 1880, **36**, 372.
10. C. Buck, U. S. P. 940580, 1909; abst. C. A. 1910, **4**, 514, Mon. Sci. 1910, **73**, 120, Zts. Schiess. Spreng. 1910, **5**, 115. Can. P. 121678, 1909
11. M. Jeschek and J. Jaresch, D. R. P. 44041; abst. Ber. 1888, **21**, 868; Wag. Jahr. 1888, **34**, 493.
12. A. Kramer, E. P. 22023, 1892; abst. J. S. C. I. 1892, **11**, 1056, 1893, **12**, 1057.
13. Wohanka & Co., E. P. 7608, 1887; abst. J. S. C. I. 1887, **6**, 472, 1888, **7**, 364, 401.
14. A. da Silva, E. P. 12617, 1901; abst. Arms and Explo. 1901, **9**, 201, J. S. C. I. 1901, **20**, 1240.
15. C. Bichel, E. P. 15528, 1885; abst. J. S. C. I. 1885, **4**, 762, 1886, **5**, 112, 457. O. Carlson, U. S. P. 1043042, 1912; abst. J. S. C. I. 1912, **31**, 1148. C. A. 1913, **7**, 258; Mon. Sci. 1913, **79**, 148; Zts. Schiess. Spreng. 1913, **8**, 179; E. P. 5707, 1910; abst. J. S. C. I. 1911, **30**, 448. U. S. P. 1122072,

Mononitrotoluene,¹ alone or in conjunction with potassium permanganate; dinitrotoluene in the hands of A. O'Neil,² S. Nauckhoff,³ E. du Pont de Nemours & Co.,⁴ and O. Teeple,⁵ dinitrotoluene in combination with nitroglycerol,⁶ camphor,⁷ dimethyldiphenylurea,⁸ nitrotoluene,⁹ or nitronaphthalene;¹⁰ trinitrotoluene alone according to the processes of Dynamit Act.-Ges. vorm. A. Nobel & Co.,¹¹ C. Bichel,¹² or in combination with dinitrotoluene,¹³ potassium chlorate,¹⁴ hexanitroethane and diethyldiphenylurea,¹⁵ ammonium,¹⁶ or barium nitrates,¹⁷ picric acid,¹⁸

abst. C. A. 1915, **9**, 380; Mon. Sci. 1915, **82**, 51. Swed. P. 30531, 1910; abst. C. A. 1912, **6**, 1992. O. Carlson and E. Otterdahl, U. S. P. 1277043, 1918; abst. J. S. C. I. 1918, **37**, 718-A; C. A. 1918, **12**, 2127; Mon. Sci. 1919, **86**, 30. C. Claessen, E. P. 16456, 1913; abst. C. A. 1915, **9**, 153; J. S. C. I. 1914, **33**, 845. E. P. 24713, 1913; E. P. 24839, 1913; abst. J. S. C. I. 1914, **33**, 669. F. P. 410239 and addition 18487; abst. C. A. 1915, **9**, 2313. Dynamit Actiengesellschaft Nobel, E. P. 6129, 1891; abst. J. S. C. I. 1891, **10**, 404; 1892, **11**, 199, 456; 1893, **12**, 525, 526. Nitroglycerin Aktiebolaget, E. P. 26334, 1910; abst. C. A. 1911, **5**, 3623; J. S. C. I. 1911, **30**, 984; Chem. Ztg. 1912, **36**, 294. A. Verge, Belg. P. 258139, 1913.

1. J. Gregorini, E. P. 1237, 1911; abst. C. A. 1912, **6**, 1991; J. S. C. I. 1912, **31**, 204; Chem. Ztg. Rep. 1912, **36**, 382; Zts. Schiess. Spreng. 1912, **7**, 331, 332.

2. E. P. 123482, 1917; abst. J. S. C. I. 1919, **38**, 443-A.

3. E. P. 26334, 1911; Norw. P. 22033, 1910; U. S. P. 1058891, 1913; abst. C. A. 1913, **7**, 1975; Mon. Sci. 1914, **81**, 20; Chem. Ztg. Rep. 1913, **37**, 399; Zts. Schiess. Spreng. 1913, **8**, 276.

4. U. S. P. 1313459; abst. C. A. 1919, **13**, 2763. E. P. 125482, 127871, 127872, 127873, 1917; abst. C. A. 1919, **13**, 2450; J. S. C. I. 1919, **38**, 604-A. Can. P. 198562, 198563, 1920. (As assignees of A. Broadbent, R. Woodbridge, O. Teeple and A. O'Neil.)

5. U. S. P. 1310848, 1919; abst. C. A. 1919, **13**, 2450.

6. Explosive called "Carbite;" see Mem. poud. salp. 1907-8, **14**, 176, 185, 190; abst. J. S. C. I. 1909, **28**, 221.

7. A. O'Neil, U. S. P. 1311909, 1311910; abst. C. A. 1919, **13**, 2597, 2598. E. P. 125482, 1917; abst. C. A. 1919, **13**, 2280. Can. P. 198561, 1920.

8. R. Woodbridge, U. S. P. 1312463; abst. C. A. 1919, **13**, 2598.

9. O. Silberrad, E. P. 13442, 1911; abst. J. S. C. I. 1912, **31**, 703; Chem. Ztg. Rep. 1912, **36**, 506.

10. O. Silberrad, E. P. 13443, 1911; abst. J. S. C. I. 1912, **31**, 703; Chem. Ztg. Rep. 1912, **36**, 506; Zts. Schiess. Spreng. 1912, **7**, 420.

11. D. R. P. 264502, 1910; abst. J. S. C. I. 1913, **32**, 1068; C. A. 1914, **8**, 251; Chem. Zentr. 1913, **84**, II, 1348; Chem. Ztg. Rep. 1913, **37**, 572; Wag. Jahr. 1913, **59**, I, 438; Zts. ang. Chem. 1913, **26**, II, 665; Zts. Schiess. Spreng. 1913, **8**, 396.

12. E. P. 16882, 1906; abst. C. A. 1908, **2**, 2034, 2050; J. S. C. I. 1907, **26**, 552; Zts. Schiess. Spreng. 1907, **2**, 277.

13. J. Rudeloff and A. and W. Allendorf, D. R. P. 201306, 1906; abst. J. S. C. I. 1908, **27**, 1178; Mon. Sci. 1912, **77**, 54; Chem. Zentr. 1908, **79**, II, 999; Chem. Zts. 1909, **8**, 1027; Wag. Jahr. 1908, **54**, I, 437; Zts. Schiess. Spreng. 1908, **3**, 374. F. P. 322994, 1908.

14. J. Rudeloff, E. P. 16599, 1908; abst. J. S. C. I. 1909, **28**, 222; Zts. Schiess. Spreng. 1909, **4**, 194.

15. C. Claessen, E. P. 24839, 1913; abst. C. A. 1915, **9**, 1249; J. S. C. I.

trinitrocresol,¹ KMnO_4 ,² or other oxidizing agents.³ "Liquid trinitrotoluene," a mixture of various isomeric di- and tri-derivatives,⁴ alone or with the addition of ammonium perchlorate,⁵ and like the above, always with nitrocellulose, have been brought forward as desirable explosives for specific purposes. Trinitromesitylene, trinitropseudocumene,⁶ liquid nitroxylenes,⁷ and nitrocymene,⁸ have been patented for blasting and propellent powder purposes. Nitrosemicellulose with nitrates of xylol, cumol and benzol, is the claim for novelty when combined with nitrocotton, as embodied in the patents of S. Adde.⁹

For manufacturing, ballistic and other details of commercial smokeless powders, gelatins and nitrocellulose-containing explosives, the subjoined references to the following specific products may be cited: Axite,¹⁰ American Wood Powder,¹¹ Arkite,¹²

- 1914, **33**, 669. Vereinigte Kohn-Rottweiler Pulverfabriken, E. P. 3937, 1909; abst. C. A. 1910, **4**, 1378; J. S. C. I. 1909, **28**, 1328. Zts. Schiess. Spreng. 1910, **5**, 383. D. R. P. 277594, 1913, abst. J. S. C. I. 1915, **34**, 199; Chem. Zentr. 1914, **85**, II, 743; Chem. Ztg. Rep. 1914, **38**, 489, Wag. Jahr. 1914, **60**, I, 360; Zts. ang. Chem. 1914, **27**, II, 580.
16. N. Ceipek, E. P. 9742, 1911, abst. J. S. C. I. 1911, **30**, 926.
17. Nitroglycerin Aktiebolaget, E. P. 26334, 1910, abst. C. A. 1911, **5**, 3623; J. S. C. I. 1911, **30**, 984; Chem. Ztg. Rep. 1912, **36**, 294.
18. H. Cottu and J. Teyssen, E. P. 402993, 1908; abst. Mon. Sci. 1911, **75**, 175. See also C. Gottig, Ber. 1898, **31**, 25; abst. J. C. S. 1898, **74**, i, 244. Anon., Arms and Explo. 1913, **21**, 85; abst. C. A. 1913, **7**, 2684.
1. H. Schneweg, D. R. P. 180724, 1904, abst. Chem. Zentr. 1907, **78**, II, 116; Chem. Zts. 1907, **6**, 76, Wag. Jahr. 1907, **53**, I, 427; Zts. ang. Chem. 1907, **20**, 1195.
2. F. Volpert, E. P. 365709, abst. C. A. 1907, **1**, 2960.
3. J. Maire, Can. P. 164990, 1915, abst. C. A. 1915, **9**, 3363.
4. Nitroglycerin Aktiebolaget, E. P. 26334, 1910; abst. C. A. 1911, **5**, 3623; J. S. C. I. 1911, **30**, 984; Chem. Ztg. Rep. 1912, **36**, 294. F. P. 422727, abst. Mon. Sci. 1913, **79**, 27.
5. S. Nauckhoff, U. S. P. 1058801; abst. C. A. 1913, **7**, 1975; Mon. Sci. 1914, **81**, 20; Chem. Ztg. Rep. 1913, **37**, 399; Zts. Schiess. Spreng. 1913, **8**, 276. U. S. P. 1061774; abst. C. A. 1913, **7**, 2309; Mon. Sci. 1914, **81**, 20; Chem. Ztg. Rep. 1913, **37**, 399. Swed. P. 30408, 1909; abst. C. A. 1912, **6**, 1902. C. van Pittius, E. P. 25274, 1910; abst. C. A. 1912, **6**, 4527; J. S. C. I. 1911, **30**, 1281.
6. G. Schultz and F. Gehre, E. P. 5687, 1905; abst. J. S. C. I. 1905, **24**, 1256; Mon. Sci. 1910, **73**, 640; Zts. Schiess. Spreng. 1906, **1**, 66.
7. W. Swint, U. S. P. 1309553; abst. C. A. 1919, **13**, 2281.
8. J. Tisell and E. Villaume, E. P. 126196, 1918; abst. J. S. C. I. 1919, **38**, 514-A.
9. E. P. 13373, 1912; abst. C. A. 1913, **7**, 3843; J. S. C. I. 1913, **32**, 453. E. P. 112618, 1917. Belg. P. 263225, 1913.
10. Kynoch, Ltd., E. P. 12892, 15564, 15565, 15566, 1905; abst. Arms Expl. 1905, **13**, 54. This consists of nitroglycerol 29.7%, guncotton 63.1%, mineral jelly and oil 5.1%, volatile matter 0.2%, and potassium nitrate 1.9%.
11. Consists of soluble nitrolignin 29.25%, insoluble nitrolignin 14.06%,

Albionit,¹ Apyrite,² Nobel Ardeer Powder,³ Ammongelatindynamite,⁴ Ammonite,⁵ Nobel Ammonia Powder No. 1,⁶ Nobel Ammonia Powder No. 2,⁷ Ammonal B.,⁸ Amberite,⁹ Poudre B,¹⁰ Bellen-

lignin (charred) 28.08%, humus 10.32%, sodium nitrate 15.27% and volatile matter 3.01%. Arms and Expl. 1893, **2**, 30. For composition of various grades see nitrolignin page 1808.

12. Said to consist of nitroglycerol 51-54%, nitrocellulose 3-4%, potassium nitrate 21-23%, wood meal 6-8%, chalk 0.5% and ammonium oxalate 14-16%. A. Dæsborough, H. M. Insp. Expl. Special Rept. 193, 1910.

1. Said to consist of nitroglycerol 67.5-72%, nitrocellulose 4.25-6%, potassium nitrate 7-9%, wood meal 1.75-2.75%, kreide 0.5%, ammonium oxalate 14-16%.

2. This is a guncotton smokeless powder used in the Swedish Navy. 3. 100 parts by weight consists of 31-34 parts nitroglycerol, 11-14 parts kieselsuhr, 47-51 parts magnesium sulphate, and 4-6 parts potassium nitrate and with or without half a part of ammonium carbonate and half a part calcium carbonate.

4. This is said to consist of nitroglycerol 50%, nitrocellulose 2.5%, ammonium nitrate 45% and ryemeal 2.5%. Ammonia gelatin consists of 40% thin blasting gelatin (97.5% nitroglycerol and 2.5% nitrocellulose), 55% ammonium nitrate and 5% charcoal.

5. Consists of 87-89 parts by weight ammonium nitrate, 11-13 parts finitronaphthalene. Arms and Expl. 1897-1898, **6**, 57.

6. Consists of 82-86 parts ammonium nitrate, 7-9 parts nitroglycerol, 8 parts wood meal, and 0.5-2 parts moisture. A. Akers-Douglas, J. S. C. I. 1904, **23**, 1044.

7. This consists of 78-82 parts ammonium nitrate, 9-11 parts nitroglycerol, 8-10 parts wood meal and moisture, 0.5-2.5 parts. A. Akers-Douglas, J. S. C. I. 1904, **23**, 1044.

8. This consists of 94-96 parts ammonium nitrate, 2.5-3.5 aluminium, charcoal 2-3 parts and moisture 0-1 part. A. Akers-Douglas, J. S. C. I. 1904, **23**, 1044.

9. This consists of nitrocellulose, insoluble, 40-47, nitrocellulose soluble, 20-23, nitroglycerol 30-40. Paraffin and shellac may be added to modify the explosive force, acetone or acetic ether 50-60 parts as solvent to 100 parts explosive. Curtis and Andre, E. P. 11383, 1891. Amberite No. 2, consists of nitrocellulose, insoluble, 13-53, nitrocellulose, soluble 59-24, barium and potassium nitrate 11-19, paraffin 6-9, and volatile matter 2-2.5. Blasting amberite consists of Amberite No. 2 with woodmeal. Arms and Expl. 1895, **3**, 191; **4**, 35; 1904, **12**, 143. Int. Ency. **7**, 375. Ann. Rep. H. M. Insp. Expl. 1876-1905. Atlas dynamite, consisting of 18-28 pyroxylin, 44-55 nitroglycerol, 5-10 pyro-powder, 20-16 nitrostarch, 1 nitromannite and 1 sodium silicate, was patented by J. Engels, E. P. 163, 1880; D. R. P. 10232, 1879; abst. Ber. 1880, **13**, 1765.

10. D. Berthelot, Bur. sci. ing. Civ. 1912, 771; Zts. Schiess. Spreng. 1912, **7**, 477; C. A. 1913, **7**, 892. Genie Civil, **61**, 206; abst. C. A. 1912, **7**, 2841. Courtois-Suffit, Mem. poudres, 1911-1912, **16**, 87; abst. J. S. C. I. 1912, **31**, 1202. J. Delpech, Compt. rend. 1919, **169**, 437; abst. C. A. 1919, **13**, 3320; J. S. C. I. 1919, **33**, 795-A. L. Dumons, Bull. sci. pharmacolog. **19**, 680; abst. C. A. 1913, **7**, 1099. C. Keller, Zts. Schiess. Spreng. 1912, **7**, 497; abst. C. A. 1913, **7**, 892. E. Lajoanio, P. P. 452154, 1912; abst. J. S. C. I. 1913, **32**, 674; C. A. 1913, **7**, 3665; Mon. Sci. 1914, **81**, 51. L. Lheure, Mem. poudres, 1909-1910, **15**, 1; abst. C. A. 1910, **4**, 962. Zts. Schiess. Spreng. 1908, **3**, 62, 82, 141; abst. Wag. Jahr. 1908, **54**, 1, 447. Jahr. Chem. 1910, **53**, 426. T. Mercul, Bull. sci. pharmacolog. **19**, 27; abst. C. A. 1913, **7**, 251.

ite,¹ Baelen dynamite,² Bronolith,³ Bracket's Sporting Powder,⁴ • •
 • Borland's Powder,⁵ B. N. Powder,⁶ Blitzlicht,⁷ Ballistite,⁸ Benzene
 ammonia Powder,⁹ Celluloidine,¹⁰ C. I. Powder,¹¹ California Ex-
 plosive,¹² Chilworth Smokeless Sporting Powder,¹³ Carbo gelatine,¹⁴

M. Patart, *Mem poudres*, **15**, 39, abst. C. A. 1910, **4**, 962. E. Reumann, *Zts. Schiess Spreng* 1910, **5**, 449, 472. P. Vieille, *Mem poudres*, **15**, 71, 89, abst. C. A. 1910, **4**, 1101, 1371. *Eng*, **86**, 579, abst. C. A. 1909, **3**, 246.

1. *Arms and Explo* 1900, **8**, 186.

2. J. Lewin, D. R. P. 42893, abst. *Wag. Jahr* 1888, **34**, 492.

3. B. Brones, D. R. P. 32891, 1884.

4. Consists of soluble nitroglucin 31.43%, insoluble nitroglucin 13.70%, lignin (charred) 13.22%, humus 18.94%, sodium nitrate 19.76%, volatile matter 2.93%. *Arms and Explo* 1893, **2**, 30.

5. This powder is similar to Schultze or E. C. Powder, but containing dimnitrocellulose only. E. P. 6289, 1895, 1593, 1900. 12th Ann. Rep. H. M. Insp. Expt. J. S. C. I. 1888, **7**, 401.

6. Consists of thoroughly purified nitrocellulose and tannin partly gelatinized, incorporated with potassium and barium nitrates.

7. This is said to be a mixture of magnesium powder and gunpowder or magnesium powder and pyroxylin. H. Pollard, *Jahr. Chem* 1888, **41**, 2904. J. Eder, *Dingl. Poly* 1888, **267**, 171, 217, 259, 328, abst. *Jahr. Chem* 1888, **41**, 2904.

8. Anon., *Arms and Explo* 1912, **20**, 20, abst. C. A. 1912, **6**, 933. Deut. Heer. Ztg. 1890, Aug. 27, *Rev. d'Artill* 1890, **36**, 573. Ann. Rep. H. M. Insp. Expt. 1890, 49. *Schw. Z. Art* 1892, **28**, 311, *Uhland's W. T.* 1892, **6**, 263; *Mitt. Seew* 1892, **20**, 285. Heeres Ztg. 1893, **18**, 573. *Schw. Z. Art* 1893, **29**, 359. *Arms and Explo* 1896, **4**, 74, 1896, **5**, 4, 1897, **5**, 111. *Jahr. Chem* 1890, **43**, 2707. E. Bravetta, *Zts. Schiess Spreng* 1912, **7**, 381, 105, 493, abst. C. A. 1913, **7**, 700, 1098; *Wag. Jahr* 1912, **58**, I, 138. E. Delepech, E. P. 127259, 128550, 1919; abst. C. A. 1919, **13**, 2449, 3013. G. Mac Roberts, J. S. C. I. 1890, **9**, 476, abst. *Wag. Jahr* 1890, **36**, 542, *Jahr. Chem* 1890, **43**, 2705; *Chem. Tech. Rep.* 1890, **29**, II, 146. W. Mills and W. Morgan, E. P. 10925, 1915. A. Nobel, *Wag. Jahr* 1878, **24**, 467. E. P. 1471, 1888, 10376, 1889; E. P. 185179, 1887, 199091, 1889. *Proc. Roy. Soc.* 1905, **76**, 1, 381, abst. *Jahr. Chem.* 1905-1908, II, 980. Paterno and Traceta Mosca, *Zts. Schiess Spreng* 1910, **5**, 145. G. Spica, E. P. 126013, 1916, abst. J. S. C. I. 1919, **33**, 513-A. Munroe-Jewell powder, flete, and C. 89 powder are similar to, or identical with ballistite. Sporting ballistite consists of nitroglycerol 37.6%, nitrocotton 62.3% and volatile matter 0.1%. *Arms and Explo* 1895, **3**, 78, 150; 1899, **7**, 104.

9. Made of nitroglycerol, nitrocellulose, ammonium nitrate, nitrobenzene and a picrate.

10. This is an explosive proposed by Turpin and consists of nitrocellulose dissolved to saturation in ether or ethyl acetate, the evaporated mass being employed like celluloid.

11. Consists of thoroughly purified nitrocellulose. Ann. Rep. H. M. Insp. Expt. 1876-1905.

12. Consists of a mixture of methyl and ethyl nitrates, nitrobenzol, methyl alcohol, pyroxylin, and nitroglycerol which has been purified by treatment with ethyl alcohol. California Explosives Co., E. P. 11326A, 1891.

13. Consists of purified nitrocellulose, gelatinized, and with or without the addition of nitrates other than ammonium nitrate.

14. Consists of 37-30 nitrocotton, 48-51 potassium nitrate, 9-12 wood meal, charcoal not more than 3, and 2 magnesium carbonate. *Arms and Explo* 1898, **6**, 57.

Cannonite,¹ Celite,² Cibalite,³ Cöronite,⁴ Coopal's Powder,⁵ Drag-onit,⁶ Diflamyr,⁷ Donarite,⁸ Dualin,⁹ Denaby,¹⁰ Diaspon,¹¹ Explosive D,¹² Dynobel,¹³ Empire Powder,¹⁴ Extra Dynamite,¹⁵ Epyrite,¹⁶ Em-

1. Consists of nitrocotton 86.4%, barium nitrate* 5.7%, vaseline 2.9%, lampblack 1.3%, potassium ferrocyanide 2.4% and volatile matter 1.3%. Cannonite No. 1, is said to consist of nitrocotton mixed or impregnated with a nitrate or nitrates, either lead nitrate or ammonium nitrate and resin with or without the addition of graphite. Cannonite No. 2 consists of nitrocotton mixed or impregnated with resin, with or without graphite. Cannonite No. 3, is said to consist of nitrocotton impregnated with barium nitrate with or without the addition of the following: lampblack, paraffin, vaseline, resin, stearine, dinitrobenzol, trinitrobenzol provided that the proportion of any one of the ingredients does not exceed 2% by weight. Arms and Explo. 1895, **3**, 63; 1898, **6**, 54.

2. Consists of nitroglycerol 56-59, nitrocellulose 2-3.5, potassium nitrate, 17-21, wood meal 8-9, ammonium oxalate 11-13, moisture 0.5-1.5. A. Akers-Douglas, J. S. C. I. 1904, **23**, 1044.

3. Consists of nitrocellulose steeped in potassium permanganate, and afterwards converted into a smokeless powder. Falkenstein and Boehm, E. P. 7238, 1893.

4. Consists of nitroglycerol 38-40, nitrocotton 1-1.5, ammonium nitrate 26-28, potassium nitrate 3-5, aluminium stearate 11-14, rye-flour 8-11, woodmeal 2-4, liquid paraffin 2-4, moisture 0.0-2.5. J. S. C. I. 1903, **22**, 710.

5. Said to consist of nitrocellulose, with or without nitrate or nitrates other than ammonium or lead nitrate, hydrocarbons or resin. Indbl. 1887, 83, 91, 99, 108; abst. Chem. Tech. Rep. 1887, **26**, I, 225.

6. Said to consist of nitroglycerol 34-37, nitrocellulose 2-3, potassium nitrate 43-46, woodmeal 11-13.5 and vaseline 6.5.

7. Said to consist of nitrocellulose mixed or impregnated with a nitrate or nitrates other than lead or ammonium nitrate.

8. Consist of ammonium nitrate 80%, trinitrotoluol 12%, starch 4%, nitroglycerol 3.8%, and nitrocellulose 0.2%. Bichel, F. P. 327868, 1902; abst. Mon. Sci. 1905, **63**, 84; Chem. Zts. 1903, **2**, 613, 715.

9. Consists of nitroglycerol, wood powder and sodium nitrate. J. Shultze, E. P. 2542, 1868. Zts. Oest. Ingen. Ver. 1870, 254; Deut. Indztg. 1870, 372; Wag. Jahr. 1870, **16**, 219. Berggeist, 1869, No. 55; Berg. u. Huttenm. Ztg. 1869, 271; Wag. Jahr. 1869, **15**, 256.

10. This is said to consist of compressed Securite with the addition of charcoal.

11. Consists of nitroglycerol 47-63, nitrocellulose 0.5-3, sodium nitrate 22-23, wood cellulose 8-18, sulfur 3-9. J. Anders, E. P. 801, 1881. Diaspon gelatine is said to consist of nitroglycerol 92-95, nitrocellulose 0.5-2, alcohol 0.5-2, with 10-15 parts of a solvent of 6 parts ether to 2 parts alcohol. J. Anders, E. P. 800, 1881; F. P. 141345, 1881.

12. Proposed by Dunn, Inter. Ency. 1909, **7**, 377. Also called Dumnite.

13. Consists of nitroglycerol, nitrocellulose, nitrosubstitution compounds, ammonium nitrate and dope. Anon., Home office order No. 239; abst. J. S. C. I. 1916, **35**, 655; C. A. 1916, **10**, 2800.

14. This consists of a gelatinized nitrocellulose base with the addition of a nitrate.

15. Consists of 48.4 nitroglycerol, 1.6 nitrocellulose, 34.5 ammonium nitrate, 5 sodium nitrate, 9 rye flour, 1 of soda and 0.5 ochre. Gelatin dynamite is nitroglycerol 71, nitrocellulose 6, wood pulp 5 and potassium nitrate 18.

16. Compound containing highly nitrated cellulose.

erald Powder,¹ E. C. Powders,² Forcite,³ Fördit,⁴ Frakturit,⁵ Fulgor,⁶ A, B and C,⁶ Fumelessite,⁷ Forsrer's Smokeless Powder,⁸ Geloxit,⁹ Glyoxyline,¹⁰ Gelatine de guerre,¹¹ Gelbite,¹² Greener's Powder,¹³ Grisoutite,¹⁴ Grennlite,¹⁵ Gas Powder,¹⁶ Gelignite,¹⁷ Granulite,¹⁸

1. This is said to contain nitrocellulose mixed or impregnated with a nitrate or nitrates other than lead or ammonium nitrate and colored with malachite green. Similar to Cooppal's Powder.

2. Consists of nitrocellulose 79.0%, potassium nitrate 4.5%, barium nitrate 7.5%, camphor 4.1%, woodmeal 3.8%, volatile matter 1.1%. E. C. Sporting Powder on analysis gave, nitrocellulose soluble, 21.79-27.95%, nitrocellulose insoluble 25.58-28.35%, cellulose unconverted 3.15-4.17%, barium and potassium nitrates 37.80-38.82%, matters soluble in benzol 0.6-1.95%, matters soluble in alcohol 21.5-0.32%, and moisture 0.0-1.87. W. Reid and D. Johnson, E. P. 619, 1882. *Inst.* **11**, 85; *abst.* J. S. C. I. 1888, **7**, 401. *Arms and Explo.* 1894, **3**, 150, 1895, **4**, 26, 1897, **6**, 36.

3. This is said to consist of nitroglycerol 98, nitrocellulose 2, sodium nitrate 76, sulfur 3, wood tar 20, and wood pulp 1. Forcite manufactured by the American Forcite Co., according to the formula of J. Lewin is composed of nitroglycerol 70%, nitrocellulose 1, dextrin 5, potassium nitrate 15, wood pulp or charcoal 9. Forcite No. 1 consists of nitroglycerol 75%, nitrocellulose 7, potassium nitrate 18. J. Lewin, E. P. 139714, 1880, D. R. P. 15073; *abst.* *Indbl.* 1881, 343; *Chem. Ind.* 1881, **4**, 358; *Chem. Tech. Rep.* 1881, **20**, II, 135. R. Lewis, *Arms and Explo.* 1911, **19**, 62, *abst.* C. A. 1911, **5**, 3910. Gelatin forcite consists of nitroglycerol 95%, and nitrocellulose 5%. *Eng. Build. Rev.* Nov. 26, 1887, *LeGenie Civil* Oct. 22, 1887.

4. Consists of nitroglycerol 24.5, nitrocellulose 1, nitrotoluene 34.0, flour 2, dextrin 2, glycerol 5.5, ammonium nitrate 32, and potassium chloride 30 parts.

5. This is said to consist of nitroglycerol 51.5-53.5, nitrocellulose 3.4, potassium nitrate 21-25, wood meal 5-7, and ammonium oxalate 14-16.

6. Fulgor A consists of 100 parts by weight of hendeka-hydronitrocellulose; 2 paraffin, 30 hexanitroammanite and 0.05 aniline black. Fulgor B consists of 100 parts by weight of hendekahydronitrocellulose and 0.05 potassium ferrocyanide. Fulgor C consists of 80 parts by weight of heptahydronitrocellulose, 20 hexahydronitrocellulose, 15 potassium chlorate, 8 barium nitrate, 1.50 paraffin and 0.05 potassium ferrocyanide. *Arms and Explo.* 1896, **4**, 122.

7. *Arms and Explo.* 1899, **7**, 119.

8. A smokeless powder made of incompletely gelatinized nitrocellulose by rolling the paste into thin bands cutting and drying. M. v. Förster, D. R. P. 22418, 1882, 83095, E. P. 1074, 1894, U. S. P. 559638, 1896. *Wag. Jahr.* 1883, **29**, 390; 1886, **32**, 324, 1895, **41**, 460.

9. Consists of nitroglycerol 54-64, nitrocellulose 4.5, potassium nitrate 13-22, ammonium oxalate 12-15, red ochre 0-1, wood meal (containing 5-15% moisture) 4-7.

10. Consists of nitrated guncotton impregnated with nitroglycerol. F. Abel, E. P. 3652, 1867.

11. Consists of nitroglycerol 86.4, soluble nitrocellulose 9.6, camphor 4.

12. This is a species of nitropaper with the addition of picric acid.

13. This is a mixture of nitrocellulose, and nitrobenzol with the addition of coloring matter consisting of graphite, lampblack or other suitable material.

14. Consists of nitroglycerol 42-45%, kieselsguhr 11-12, magnesium sulfate 43-47%. This formula was proposed by Faile.

15. This consists of purified nitrocotton mixed or impregnated with nitrate or nitrates other than ammonium or lead nitrate with or without

Hudson's Explosive,¹ Horn Powder,² Hornite,³ Henrite,⁴ Indurite,⁵ Kol's Powder,⁶ Kresylite,⁷ Kynoch Smokeless Powder,⁸ Kinetite,⁹ J. Powder,¹⁰ Johnson's Powder,¹¹ Lenite,¹² Lithofracteur,¹³ Liverpool Cotton Powder,¹⁴ Cellulose dynamite (Nitrocellulose dynamite),¹⁵

charcoal and paraffin Home office Ann. Rept. 1894, Doc X-30960.

16. This is a simple modification of Melland's paper powder.

17. Gelignite consists of nitroglycerol 60-61, nitrocellulose 4-5, wood pulp 7-9, potassium nitrate 27. Sun gelignite consists of nitroglycerol 57-59, nitrocellulose 2-3, wood meal 8-10, potassium nitrate 25-31. Nobel gelignite consists of 54-63 nitroglycerol, 3-5 nitrocotton, 26-34 potassium nitrate, 6-9 wood meal and 0-5 chalk. Arms and Explo. 1897, **5**, 81; 1898, **6**, 57. La Societe des Explosifs Industrielles, E. P. 20069, 1896; abst. Arms and Explo. 1897, **5**, 81.

18. Analysis of this product gave nitrocotton 46.28, barium nitrate 45.48, paraffin 7.84, moisture 0.4%.

1. This is a mixture of nitroglycerol with nitrocellulose dissolved in acetone and other solvents.

2. This consists of guncotton saturated with nitrobenzol and acetic ether.

3. This was the name given to an experimental smokeless powder composed of nitrocotton dissolved in acetone or acetic ether.

4. This is manufactured by Henrite Explosives, Ltd., Dartford, Kent, England.

5. Consists of nitrocellulose colloided by means of nitrobenzene. C. Munroe, U. S. P. 489684, 1893, E. P. 580, 1893; Can. P. 44909, 1893; Int. Ency. 1909, **7**, 375; Proc. U. S. Nav. Inst. 1896, **22**, 599. Eng. News, 1896, **36**, 286.

6. This is a gelatinized nitrocellulose powder. Insp. Expl. Rept. 1891, 18.

7. M. Giua, Gaz. chim. ital. 1915, **45**, II, 32; abst. C. A. 1916, **10**, 1176.

8. Arms and Explo. 1898, **6**, 174.

9. Consists of nitrobenzene 16-21, guncotton 0.75-1.0, potassium chlorate or nitrate 75-82.25 and antimony sulfide 0.0-3. T. Petry, O. Fallenstein and H. Lisch, D. R. P. 31786, 1884; E. P. 10986, 1884; abst. J. S. C. I. 1885, **4**, 509; 1887, **6**, 2, 12; Berg. Huttenm. Ztg. 1885, 65; Dingl. Poly. 1885, **256**, 408; Jahr. Chem. 1885, **38**, 2102. H. Dulitz, E. P. 12837, 12838, 1885; abst. Wag. Jahr. 1887, **33**, 574; Jahr. Chem. 1885, **38**, 2102. Chem. Centr. 1885, **56**, 348.

10. This is a smokeless sporting powder manufactured in France and consisting of 83% guncotton and 17% ammonium bicarbonate.

11. Johnson-Borland powder for military arms consists of nitrocellulose 50%, potassium nitrate 40% and torrefied starch or lampblack 10%. Johnson-Borland powder for sporting arms consists of nitrocellulose 50%, potassium nitrate 22%, barium nitrate 25% and torrefied starch or lampblack 3%.

12. This is a mixture of picric acid and collodion.

13. This consists of sodium nitrate 65 parts, sulfur 13, and nitrocellulose 32. Merle, Mon. Sci. 1897, **49**, 25; abst. Wag. Jahr. 1897, **43**, 486. Rev. univ. 1880, **7**, 21. G. Bergrath and Burkart, Deut. Ind. Ztg. 1872, No. 45; Poly. Centr. 1870, **36**, 1139, 1448; 1872, **38**, 1482. Mining J. 1879, **39**, 108.

14. This is a mixture of guncotton and potassium nitrate. Eng. Mining J. April 16, 1881.

15. Consists of nitroglycerol 75%, and nitrocellulose 25%. J. S. C. I. 1884, **3**, 533.

- Müllerite,¹ Matagnite Gelatine,² Blasting Matagnite,³ Motorite,⁴ Melanite,⁵ M. N. Smokeless Powder,⁶ Mackie Powder,⁷ Maximite,⁸ Dynamite Nitro-benzoïque,⁹ Nitropylin (Collodlin)¹⁰ Nitroleum,¹¹ Normanit,¹² Normal Powder,¹³ Nitrolite,¹⁴ Nitroline (Vigorite)¹⁵ Oarite,¹⁶ Orange Powder,¹⁷ Potentite,¹⁸ Powerite,¹⁹ Phoenix Powder,²⁰ Plera,²¹ Paleine (Straw Dynamite),²² Picric nitro gelatine,²³ Präposit,²⁴

1. This powder is stated to be thoroughly gelatinized guncotton, Arms and Explo. 1899, **7**, 84, 140

2. Consists of nitroglycerol and purified nitrobenzol, or either of them thickened by being combined with nitrocellulose, washed purified and mixed or incorporated with wood meal

3. Consists of nitrocellulose, nitroglycerol and nitrobenzol. Matagnite gelatine on analysis gave nitroglycerol 68%, nitrocellulose and wood meal 11.4% and potassium nitrate 20.6

4. Consists of nitroglycerol 70% and guncotton 30%. H. Maxim, Sci 1908, **28**, 820; abst. C. A. 1909, **3**, 375.

5. Formula proposed by Faille consists of nitrocellulose 13%, 17% and nitroglycerol 83%-87%. Pharm. Centralt 1899, **41**, 63

6. This is an American smokeless powder consisting of guncotton gelatinized in acetic ether.

7. This is a mixture of nitrocellulose and barium nitrate. Rev. d'Artill 1877, **9**, 298, 375

8. This is a mixture of nitrocellulose, nitroglycerol and castor oil gelatinized by acetone.

9. Contains nitroglycerol 15.45, nitrocellulose 1.3, nitrobenzol 5.10 and ammonium nitrate 50-73. This was patented by Vending in 1882

10. Apparently synonymous with Volkman's wood powder containing nitrocellulose. Chem. Tech. Rep 1876, **15**, I, 389, Deut. Indztg 1876, 78, Wag. Jahr 1876, **22**, 479

11. This powder contains pyroxylin, sawdust, potassium nitrate and chlorate and nitroleum. C. Delaney, U. S. P. 184762, 1876

12. Contains nitroglycerol 32.5-34.5, nitrocellulose 1.2, potassium nitrate 42-46.5, wood meal 7-9, ammonium oxalate 10-12, charcoal 1.2

13. This powder is composed of nitrocellulose, gelatinized by a suitable process and a small amount of calcium carbonate. Arms and Explo 1895, **3**, 135, 186, 1896, **4**, 201, 1896, **5**, 9, 1899, 791.

14. Consists of nitroglycerol 94.99, nitrocellulose 1.6, ammonium sodium or potassium nitrate 50-150. C. Lamm, E. P. 14320, 1896

15. E. Bjorkman, E. P. 2459, 1875.

16. This powder contains nitroglycerol, nitrocellulose, dinitrobenzol, and barium or potassium nitrate.

17. This powder received its name from Orange Mills, N. Y., established by Laflin and Rand in 1808. Orange Lightning Powder is a sporting powder analogous to E. C. Powder.

18. Consists of a nitrated guncotton. Proc. U. S. Nav. Inst. **11**, 87, Eng. Min. J., Sept. 15, 1883; J. S. C. I. 1883, **2**, 310.

19. Consists of nitroglycerol, nitrocellulose, calcium picrate and mineral jelly. Powerite Explosive Co., New Zeal. P. 16838, 1915.

20. Contains nitroglycerol 28-31, nitrocellulose 0.0-1, potassium nitrate 30-34, wood meal 33-37 and moisture 2-6. A. Akers-Douglas J. S. C. I. 1904, **23**, 1044.

21. This is the name given to rifle guncotton.

22. This is a mixture of nitroglycerol and nitrocellulose made from straw. J. Lanfrey and J. Renard, D. R. P. 12115, 1880, F. P. 144789, 1878; Addn. Dec. 18, 1878, Ital. P. Aug. 17, 1878, Port. P. June 11, 1879; Belg. P.

- Plastomenite,¹ Petralithe,² Pigon's Smokeless Sporting Powder,³ Pyrocollodion,⁴ Rooslyn Smokeless Powder No. 1,⁵ Rifleite,⁶ Rippite,⁷ Russelite,⁸ Rottweil,⁹ S. Powder,¹⁰ "Extra," "Express," and "Patent" dynamite,¹¹ Samsonite,¹² Syndite,¹³ Sengite,¹⁴ Spandau Powder,¹⁵ Saxonit,¹⁶ Schwab Powder,¹⁷ S. T. Dynamite,¹⁸ Studer Powder,¹⁹ Steelite,²⁰ Solenite,²¹ Sierch Powder,²² New Schultze Powder,²³ Swed. P. Aug. 20, 1880; Aust. P. 5524. Bruneau, Mem. poudr. salp. 4, 205.
23. A mixture of nitroglycerol with 10% picric acid, gelatinized with soluble nitrocellulose.
24. Anon., Zts. Schiess. Spreng. 1914, 9, 96; abst. C. A. 1914, 8, 1872.
1. Consists of nitrocellulose 68%, trinitrotoluene 13%, dinitrotoluene 6%, barium nitrate 13%. H. Guetler, D. R. P. 56946, 94292; abst. Wag. Jahr. 1891, 37, 1176. Bayer. Ind. Gewbl. 1891, 23, 497. Home Office Ann. Rept. 1895, 73; Doc. No. X-45077.
2. J. Lewin, E. P. 2140, 1880. See R. Sjöberg, D. R. P. 14830, 14836; E. P. 448, 1887; abst. Wag. Jahr. 1889, 35, 478.
3. This powder consists of nitrocotton, with or without barium nitrate and dried starch. Pigon's Military smokeless powder consists of thoroughly purified guncotton suitably gelatinized.
4. Arms and Explo. 1897, 5, 53; 1898, 6, 61.
5. This is a nitrocotton mixed with barium or potassium nitrate, or neutral paraffin or vaseline or starch. A Hargreaves, E. P. 24235, 1894; abst. Arms and Explo. 1895, 4, 47.
6. This consists of nitrolignin or nitrocotton, a nitrate other than ammonium or lead, and with or without the addition of dinitrobenzol, dinitrotoluol and graphite. Arms and Explo. 1895, 3, 182; 1897, 5, 56; 1900, 8, 21, 29, 50, 69, 82.
7. Consists of nitroglycerol 59.5-62.25, nitrocellulose 3.5-4.5; potassium nitrate 18-20, wood meal 3.5-5.5; castor oil 0.5-1.5 and ammonium oxalate 9-11. Super Rippite consists of nitroglycerol 53.51, nitrocellulose 4.2, potassium nitrate 13.5-15.5, borax 15.5-17.5, potassium chloride 9.7 and moisture 8.5.
8. This is composed of nitroglycerol 40-42, nitrocellulose 1.75-2.75; potassium nitrate 24-26, wood meal 3-5, ammonium oxalate 22-24, and calcium carbonate 0.5.
9. Arms and Explo. 1901, 9, 48.
10. This is a smokeless sporting powder manufactured in France and consisting of guncotton and barium and potassium nitrates.
11. C. Herlin, Zts. Schiess. Spreng. 1914, 9, 389; abst. C. A. 1915, 9, 1116.
12. Consists of nitroglycerol 57-60, nitrocellulose 3-4, potassium nitrate 17-19, wood meal 5-7, ammonium oxalate 12.5-14.5 and 0-1.5 moisture. J. S. C. I. 1909, 26, 915.
13. Consists of nitroglycerol 10-12, nitrocellulose 0.1-0.3, glycerol 2-5, starch 2-5, ammonium nitrate 45-49, sodium nitrate 7-9, sodium chloride 28-28 and moisture 0-2.
14. J. Udal, S. African J. Ind. 1918, 1, 988; abst. C. A. 1918, 12, 2442.
15. This is a German camphor containing powder digested with ether.
16. Consists of nitroglycerol 42.5-62, nitrocellulose 5-25, potassium nitrate 16-27.5, wood meal 3.5-8, kreide 0.5, ammonium oxalate 9-27.
17. This is an Austro-Hungarian product invented by Schwab, and consists of nitrocellulose.
18. This is identical with E. C. Dynamite.
19. This powder is for use in small ball rifles and is probably composed

der, "New E. C. (Improved),"¹ Stowite,² Tonite,³ Trauzls⁴ Dynamite,⁵ Saint Marc Powder,⁶ Tubeite,⁶ Titan Powder,⁷ H. Dautriche,⁸ Troisdorf,⁹ Vigorite,¹⁰ Velodite,¹¹ Xyloglodine,¹² Walsrode Powder,¹³ Wellorech's Powder,¹⁴ Wass Powder,¹⁵ Warren's Powder,¹⁶ Wetteren Powder,¹⁷ Monachite,¹⁸ Monarkite,¹⁹ Permon of nitrocellulose.

20. This product consists of nitrated mixture of resin and starch meal together with potassium chlorate and from 0.5-5% powdered aluminum E. Steele, U. S. P. 762447, 1904, 799687, 1905; 902619, 1908, E. P. 14676, 1901; 11000, 1904; 4114, 1906; D. R. P. 224153; E. P. 336783, 1903, abst. J. S. C. I. 1904, **23**, 190, 386, 728, 1907, **26**, 280, 1908, **27**, 1178, C. A. 1909, **3**, 717; Wag. Jahr. 1910, **56**, I, 490. Mem. poudr. salp. **15**, 175.

21. This powder consists of nitroglycerol, mineral jelly, and nitrocellulose.

22. This is an Austrian smokeless powder similar to Schwab powder. Schwab powder is a smokeless powder consisting of pure nitrocellulose and coated with graphite.

1. Consists of nitro tar, pyroxylin, barium and potassium nitrates and sulfur. Every Saturday, 1869, 538. R. Griffith, E. P. 11808, 1884. E. Schultze, E. P. 15129, 1885; abst. J. S. C. I. 1886, **5**, 679, 1888, **7**, 401. Ital. P. 31611, 1892.

2. This consists of nitroglycerol 58.61, nitrocellulose 4.5.5, potassium nitrate 18-20, wood meal 6.7, ammonium oxalate 11-15.

3. This consists of guncotton 50.52, barium nitrate 40.47. Tonite No. 2 consists of guncotton 50.52, barium nitrate 40.47 and charcoal. Tonite No. 3 consists of guncotton 18.20, barium nitrate 67.70, dinitrobenzol 11-31 and moisture 0.5-1%. J. Hueter, D. R. P. 3867, 1878, abst. Dingt. Poly. 1879, **232**, 188, Ind. Ztg. 1879, 121, Ber. 1879, **12**, 208; Chem. Ind. 1879, **2**, 50; Chem. Centr. 1879, **50**, 448; Chem. Ztg. 1879, **3**, 96; Berg. u. Huttenm. Ztg. 1879, 175; Wag. Jahr. 1879, **25**, 423. Bel. Eng. **18**, 561, **19**, 321; Min. Sci. Press. Aug. 27, 1881, Abbot, Eng. Min. J. **37**, 26, abst. Wag. Jahr. 1884, **30**, 381.

4. Consists of nitroglycerol 75, nitrocellulose 25 and charcoal 2.

5. It is said this is a guncotton powder and to have been made in imitation of the French Vieille powder.

6. Arms and Explo. 1896, **5**, 4.

7. This is a nitrated vegetable fiber, mannite, with either amylin or inuline.

8. H. Dautriche, Mem. poudres salpet. 1911 1912, **16**, 212, 214, 224; abst. J. S. C. I. 1912, **31**, 1202.

9. This is said to consist of gelatinized nitrocellulose with or without the addition of nitrates.

10. O. Nordenfeldt, E. P. 2459, 1875.

11. Arms and Explo. 1904, **12**, I, 25.

12. This consists of nitrated starch or glycerol. U. S. P. 99060, 1870.

13. This powder is said to consist of thoroughly purified nitrocellulose mixed with calcium carbonate and suitably gelatinized.

14. This is a pure nitrocellulose powder.

15. Consists of nitrocellulose partially gelatinized and mixed with dimanganic trioxide (Mn_2O_3).

16. This consists of 1 part nitrocellulose to 10 parts nitroglycerol.

17. This powder is composed to nitrocellulose and barium nitrate dissolved in amyl acetate.

18. Consists of ammonium nitrate 64, alkaline nitrate 3, nitrocellulose 1, wood charcoal 1, alkaline chloride 17, trinitroxyline 14.

19. This consists of nitroglycerol 11-13, nitrocotton 0.5, ammonium

- Powder,¹ French Smokeless Sporting Powders,² Sebastin,³ Haylite,⁴ and Neonol.⁵

The details of the above individual products will be found in Volume Seven of this series.

Those interested in the detailed methods of powder manufacture, graining, solvent extraction, drying, etc., will find information in the processes of F. Abel and E. Brown,⁶ A. Aeschbach,⁷ H. Auchu,⁸ W. Baker,⁹ Becker,¹⁰ G. Beneke,¹¹ C. Bichel,¹² E. Blyth,¹³ J. Carter,¹⁴ Centralstelle für Wissenschaftlichtech-

nitrate 48-51, sodium nitrate 6.5-8.5, sodium chloride 23-26, starch 3-5, mineral jelly 1.5-2.5, moisture 0-2. Chem. Trade J., March 14, 1914; abst. J. S. C. I. 1914, **33**, 334.

1. Consists of nitroglycerol 11-13, nitrocellulose 0.5-0.2, ammonium nitrate 54-57, starch 8.5-10.5, sodium chloride 16-18, glycerol 3-5, moisture 0-2.

2. J. Powder consists of nitrocellulose 83% ammonium bichromate 14% and potassium bichromate 3%. T. Powder is a gelatinized flake powder manufactured from nitrocellulose of the highest degree of nitration. M Powder consists of 71 barium nitrate, nitrocellulose 20, potassium nitrate 5, camphor 3, gelose 1. S. Powder consists of nitrocellulose 65, barium nitrate 20, potassium nitrate 36.

3. This is an explosive of 50 parts nitroglycerol, 10 parts nitrocellulose, 15 parts coal powder, 10 parts potassium nitrate, 3 parts sodium bicarbonate, 10 parts lead peroxide and 2 parts paraffin. Rev. Chim. Ind. 1892, **3**, 119.

4. Consists of nitroglycerol 25-27, nitrocotton 0.5-1.5, wood meal 12-14, potassium nitrate 19-21, barium nitrate 19-21, mineral jelly 6-8, ammonium oxalate 10-12, and moisture 0.5-2.5. Explosives in Coal Mine Order of March 31, 1913; Coal mines Act. Statutory Rules and orders 1913, No. 359; abst. J. S. C. I. 1913, **32**, 551.

5. This is said to consist of nitroglycerol 20-22, nitrocotton 0.5-1.5, trinitrotoluene and dinitrotoluene 0.0-0.4, wood meal 14-16, potassium perchlorate 36-38, ammonium oxalate 24-26, and moisture 0-2 parts. Explosives in Coal Mines Order of March 31, 1913; Coal Mines Act. Statutory Rules and Orders 1913, 359; abst. J. S. C. I. 1913, **32**, 551. Tremonte SII is 33.0 dinitroglycerol, 1.0 collodion cotton, 12.0 pea flour, 2.5 trinitrotoluol, 25.0 sodium chloride and 28.5 ammonium nitrate. Salite, an explosive of 11.77 nitroglycerol, 0.54 collodion cotton, 53.63 ammonium nitrate, 8.46 dinitrotoluol, 23.08 sodium chloride and 2.52 dextrin.

6. E. P. 3115, 1868.

7. E. P. Appl. 7022, 1918; abst. J. S. C. I. 1919, **38**, 236-A.

8. U. S. P. 881365; abst. J. S. C. I. 1908, **27**, 421; Zts. Schiess. Spreng. 1908, **3**, 275. U. S. P. 881366, 881367, 881368; abst. Zts. Schiess. Spreng. 1908, **3**, 275. U. S. P. 902464, 902465; abst. J. S. C. I. 1908, **27**, 1478. U. S. P. 902850. E. P. 4128, 1908. India P. Appl. 130, 1908. See also Sprengst Waffen u. Munition, 1910, **5**, No. 8.

9. E. P. 15605, 1912.

10. Art. Monatshefte; abst. Zts. Schiess. Spreng. 1911, **6**, 114.

11. E. P. 1888, 1900; abst. J. S. C. I. 1901, **20**, 279.

12. E. P. 17194, 1910; abst. C. A. 1911, **5**, 2952; J. S. C. I. 1910, **29**, 1412; Zts. Schiess. Spreng. 1911, **6**, 133.

13. E. P. 135813, 1919; abst. J. S. C. I. 1920, **39**, 84-A.

14. U. S. P. 902840, 1908.

nische Untersuchungen, G. m. b. H.,¹ H. Chapman,² D. Chiara-
viglio and Bombrini Parodi-Delfino,³ C. Claessen,⁴ E. Clark,⁵
G. Clark,⁶ A. Cochrane,⁷ W. Dalton,⁸ A. Darvas,⁹ J. Delpech,¹⁰
Deutsche Sprengstoff Akt.-Ges.,¹¹ C. Dobbs, and R. Pitman,¹²
du Pont de Nemours Powder Co.,¹³ C. Duttonhofer,¹⁴ Electric
and Ordnance Accessories Co. and R. Hall,¹⁵ Explosivstoff-Werke
Spiralit Ges.,¹⁶ A. Favier,¹⁷ J. France,¹⁸ K. Fuchs,¹⁹ E. Gathmann,²⁰
C. Grau,²¹ J. Graydon,²² G. Greiss,²³ H. Güttler,²⁴ O. Guttman.²⁵

1. D. R. P. 250037, abst. C. A. 1912, **6**, 3525; Chem. Ztg. Rep. 1912, **36**, 494; Wag. Jahr. 1912, **58**, I, 428; Zts. ang. Chem. 1912, **25**, 1879; Zts. Schiess. Spreng. 1912, **7**, 454.
2. E. P. 1115, 1889, abst. J. S. C. I. 1889, **8**, 160, 1890, **9**, 580.
3. E. P. 126687, 1917, abst. J. S. C. I. 1919, **38**, 514-A.
4. E. P. 3116, 1911, abst. C. A. 1912, **6**, 1992; J. S. C. I. 1912, **31**, 303.
5. F. P. 426437, 1911, abst. J. S. C. I. 1911, **30**, 984.
6. E. P. 567, 1882; abst. J. S. C. I. 1882, **1**, 76.
7. E. P. 1210, 1868.
8. E. P. 5898, 1883.
9. E. P. 108450, 1916; abst. J. S. C. I. 1917, **36**, 1087.
10. E. P. 13877, 1901; abst. J. S. C. I. 1902, **21**, 904.
11. U. S. P. 1316360, 1919, abst. C. A. 1919, **13**, 3013.
12. E. P. 24960, 1911; abst. C. A. 1913, **7**, 1612; J. S. C. I. 1913, **32**, 82; Zts. Schiess. Spreng. 1913, **8**, 257.
13. E. P. 13860, 1906; F. P. 367548, 1906, abst. J. S. C. I. 1906, **25**, 1174.
14. U. S. P. 569660; U. S. P. 733741; abst. J. A. C. S. 1904, **26R**, 82; U. S. P. 733742; abst. J. A. C. S. 1904, **26R**, 82; U. S. P. 790018, 791111, 733742; abst. J. A. C. S. 1904, **26R**, 82; U. S. P. 827674, 836704, abst. C. A. 1907, **1**, 488, 504; Mon. Sci. 1907, **67**, 52; Zts. Schiess. Spreng. 1907, **2**, 117; U. S. P. 851607, abst. J. S. C. I. 1907, **26**, 599; U. S. P. 914390, abst. J. S. C. I. 1909, **28**, 816; U. S. P. 929815; abst. J. S. C. I. 1909, **28**, 1007; U. S. P. 944500, abst. C. A. 1910, **4**, 530; U. S. P. 945109; abst. C. A. 1910, **4**, 530; U. S. P. 993353, abst. C. A. 1911, **5**, 2557; U. S. P. 1001072; abst. C. A. 1911, **5**, 3911; U. S. P. 1017286; U. S. P. 1106138; abst. C. A. 1914, **8**, 3238; J. S. C. I. 1914, **33**, 943; U. S. P. 1308343, abst. C. A. 1919, **13**, 2282; E. P. 7712, 1903, abst. J. S. C. I. 1903, **22**, 822; Mon. Sci. 1905, **63**, 68; Chem. Ztg. 1904, **28**, 758; E. P. 7695, 1903, abst. J. S. C. I. 1903, **22**, 822; E. P. 16809, 1906; abst. J. S. C. I. 1907, **26**, 167; E. P. 24296, 1914; F. P. 331066, 331067, 367945; D. R. P. 189009; abst. Wag. Jahr. 1907, **53**, I, 426; Zts. Schiess. Spreng. 1907, **2**, 411.
15. E. P. 8776, 1902; abst. J. S. C. I. 1902, **21**, 927.
16. E. P. 11369, 1907.
17. E. P. 8250, 1898; abst. Arms & Explo. 1899, **7**, 29.
18. E. P. 2139, 1885; abst. J. S. C. I. 1885, **4**, 141, 408; E. P. 6875, 1888; abst. J. S. C. I. 1888, **7**, 416, 470; E. P. 20895, 1896; abst. J. S. C. I. 1900, **15**, 757; 1897, **16**, 711, 720.
19. U. S. P. 356064, 1887; E. P. 5364, 1890, abst. J. S. C. I. 1890, **9**, 438, 792, 821.
20. D. R. P. 311294, abst. J. S. C. I. 1919, **38**, 531-A; Chem. Zentr. 1919, **90**, II, 575.
21. E. P. 18920, 18923, 1900; abst. Arms & Explo. 1901, **9**, 13; J. S. C. I. 1901, **20**, 68, 69.
22. Zts. Schiess. Spreng. 1908, **3**, 321, 382; abst. Wag. Jahr. 1908, **54**, I, 451.

D. Hickie and G. Beutner,¹ Fortuna-Werke A. Hirth,² H. Hoffmann,³ B. Hotchkiss,⁴ G. Jones,⁵ A. Keller,⁶ King's Norton Metal Co. Ltd., T. Bayliss, H. Smith and H. Brownsdon,⁷ A. Cocking and Kynoch, Ltd.,⁸ Lafin & Rand Powder Co.,⁹ P. Landrin,¹⁰ J. Longridge,¹¹ A. Luck and C. Nichols,¹² S. Mackie,¹³ M. Mallet,¹⁴ H. Maxim,¹⁵ A. Micciollo,¹⁶ L. Morane,¹⁷ A. Musker,¹⁸ A. Nobel,¹⁹

- 22 E. P. 4795, 4796, 4797, 1894
- 23 D. R. P. 156441; abst. *Wag. Jahr* 1904, **50**, I, 363, *Chem. Ztg.* 1904, **28**, 1158
- 24 E. P. 12085, 1894
- 25 *Dingl. Poly.* 1889, **273**, 66, 1890, **275**, 114 *Proc. Inst. Civ. Eng.* 1900-1901, **143**, Part I
 - 1 E. P. 12081, 1894, abst. *Arms & Explo.* 1895, **3**, 178, *J. S. C. I.* 1894, **13**, 782, 1895, **14**, 540, 596
 - 2 E. P. 25359, 1911, abst. *C. A.* 1913, **7**, 1612, *J. S. C. I.* 1912, **31**, 1203, *F. P.* 438081, abst. *J. S. C. I.* 1912, **31**, 663, *C. Hirth*, U. S. P. 1180850, 1916.
 - 3 U. S. P. 620775, 1899, abst. *Chem. Ztg.* 1899, **23**, 276
 - 4 E. P. 1552, 1865
 - 5 U. S. P. 809307, 1907, 882114, 1908
 - 6 *Zts. Schuss. Spreng.* 1915, **10**, 91
 - 7 E. P. 28053, 1906, abst. *C. A.* 1908, **2**, 483, *J. S. C. I.* 1907, **26**, 1163.
 - 8 E. P. 22965, 1901, abst. *J. S. C. I.* 1902, **21**, 1412 E. P. 456, 1903; abst. *J. S. C. I.* 1903, **22**, 1366 E. P. 12892, 1905, abst. *J. S. C. I.* 1906, **25**, 337; *Zts. Schuss. Spreng.* 1906, **1**, 181 E. P. 28177, 1911, abst. *C. A.* 1913, **7**, 1975, *J. S. C. I.* 1913, **32**, 111
 - 9 E. P. 13758, 1902, abst. *J. S. C. I.* 1902, **21**, 1155
 - 10 E. P. 130093, 1918, abst. *J. S. C. I.* 1919, **38**, 742-A
 - 11 E. P. 8093, 1885, abst. *J. S. C. I.* 1885, **4**, 513, 558
 - 12 E. P. 24136, 1897, abst. *Arms & Explo.* 1898, **6**, 227, *Mon. Sci.* 1899, **54**, 152, *Chem. Ztg.* 1899, **23**, 203 E. P. 17877, 1907, abst. *J. S. C. I.* 1908, **27**, 923, *Zts. Schuss. Spreng.* 1908, **3**, 436.
 - 13 E. P. 445, 1873.
 - 14 E. P. 3879, 1911, abst. *C. A.* 1912, **C**, 294; *J. S. C. I.* 1911, **30**, 1089.
 - 15 U. S. P. 174561, abst. *J. A. C. S.* 1892, **14**, 140 U. S. P. 538618, 753994, 988798, abst. *C. A.* 1911, **5**, 2179 E. P. 2628, 1887, abst. *J. S. C. I.* 1887, **6**, 236, 1888, **7**, 56 E. P. 1951, 1890, abst. *J. S. C. I.* 1891, **10**, 161 E. P. 5209; abst. *J. S. C. I.* 1890, **9**, 438, 1891, **10**, 292, 484 E. P. 17994, 1894, abst. *J. S. C. I.* 1895, **14**, 788, 820, 1010 E. P. 8569, 1895; abst. *Arms & Explo.* 1895, **3**, 214, *J. S. C. I.* 1895, **14**, 820, 1897, **16**, 498, *Mon. Sci.* 1896, **48**, 87 E. P. 11299, 1895, abst. *Arms & Explo.* 1895, **3**, 215; *J. S. C. I.* 1897, **16**, 498 E. P. 16861, 1895, abst. *J. S. C. I.* 1895, **14**, 846, 1908, 1896, **15**, 51, 1897, **16**, 498 E. P. 16862, 1895; abst. *Arms & Explo.* 1897, **5**, 181, *J. S. C. I.* 1895, **14**, 843, 1896, **15**, 942, 1897, **16**, 161, 498 E. P. 7178, 1897, abst. *J. S. C. I.* 1897, **16**, 498, 1898, **17**, 375 E. P. 15499, 1897; abst. *Arms & Explo.* 1897, **6**, 13, *J. S. C. I.* 1897, **16**, 656, 716, 760 E. P. 3468, 1898, abst. *J. S. C. I.* 1898, **17**, 196 E. P. 3529, 1900; abst. *Arms & Explo.* 1900, **8**, 177, *J. S. C. I.* 1900, **19**, 296, 880 E. P. 13620, 1901, abst. *Arms & Explo.* 1901, **9**, 183, *J. S. C. I.* 1901, **20**, 1141 E. P. 9480, 1902, abst. *Arms & Explo.* 1903, **11**, 80, *J. S. C. I.* 1903, **22**, 511 E. P. 9481, 1902; abst. *Arms & Explo.* 1903, **11**, 65, *J. S. C. I.* 1903, **22**, 441 E. P. 28376, 1904; abst. *J. S. C. I.* 1905, **24**, 457
 - 16 F. P. 383342, 1907, abst. *C. A.* 1909, **3**, 1802
 - 17 E. P. 24561, 1899, abst. *Arms & Explo.* 1900, **8**, 54; *J. S. C. I.* 1900, **19**, 200, 375
 - 18 E. P. 108, 1905.

Ordnance Improvement Co.,¹ P. Paris,² W. Peyton,³ F. Raschig,⁴ M. Saladin,⁵ J. Schrader,⁶ P. Schmidt,⁷ R. Schupphaus,⁸ R. Scott,⁹ Seovill Manufacturing Co. and R. Sperry,¹⁰ T. Shaffner,¹¹ O. Siedentoff,¹² H. Talley,¹³ E. Turpin,¹⁴ A. Tytow,¹⁵ A. Voigt,¹⁶ Vereinigte Köln-Rottweiler Pulverfabriken,¹⁷ A. Verge,¹⁸ W. Waddell,¹⁹ G. Wadsworth,²⁰ J. Walsh,²¹ and M. Wilkins and H. Aspinwall,²² C. Volnev,²³ W. Morgenstern,²⁴ W. Phillips,²⁵ A. Moreschi,²⁶ Bochum-Lindener Zundwaren und Wetterlampenfabrik, C. Koch,²⁷ D'Avis,²⁸ Crittall and Musgrave,²⁹ and P. du Buit.³⁰

19. E. P. 1988, 1889, abst. J. S. C. I. 1889, **8**, 160, 1890, **9**, 326. E. P. 12307, 1889. E. P. 23260, 1891, abst. J. S. C. I. 1891, **13**, 1218, 1895, **14**, 846, 1902. Dynamit Actien Ges. vorm. A. Nobel & Co., E. P. 16673, 1911, abst. J. S. C. I. 1912, **31**, 258, Zts. Schiess Spreng 1912, **7**, 497.
1. E. P. 3927, 1915, F. P. 178600, 1915, abst. J. S. C. I. 1916, **35**, 439.
2. U. S. P. 1282623, abst. C. A. 1919, **13**, 488.
3. E. P. 17935, 1895, abst. Arms & Explo. 1896, **4**, 210. J. S. C. I. 1895, **14**, 912, 1896, **15**, 638, 672.
4. Belg. P. 251071, 1912.
5. F. P. 437228, 1911.
6. U. S. P. 677803, 682390. E. P. 2651, 1901. D. R. P. 136861, abst. Wag. Jahr. 1902, **48**, 1, 365.
7. Belg. P. 246684, 1912.
8. D. R. P. 106057, abst. Chem. Centr. 1900, **71**, 1, 888, Wag. Jahr. 1899, **45**, 416, Zts. ang. Chem. 1899, **12**, 1229.
9. E. P. 15259, 1902, abst. J. S. C. I. 1902, **21**, 1216.
10. E. P. 101961, abst. J. S. C. I. 1917, **36**, 203. C. A. 1917, **11**, 889.
11. U. S. P. 60567, 1866.
12. E. P. 6640, 1896, Arms & Explo. 1897, **5**, 8.
13. U. S. P. 940216, abst. Chem. Ztg. Rep. 1910, **34**, 13.
14. E. P. 15089, 1885, abst. J. S. C. I. 1885, **4**, 762, 1886, **5**, 46, 679.
15. Zts. Schiess Spreng 1911, **6**, 382, abst. C. A. 1912, **6**, 425.
16. Zts. Schiess Spreng 1911, **6**, 204, abst. C. A. 1911, **5**, 3316. E. P. 1712, 1911, F. P. 425550, 1911, abst. J. S. C. I. 1911, **30**, 926, 1912, **31**, 204, C. A. 1912, **6**, 1991.
17. D. R. P. 254431, 1911, abst. C. A. 1913, **7**, 1291, J. S. C. I. 1913, **32**, 214, Chem. Zentr. 1913, **84**, 1, 363, Chem. Ztg. Rep. 1913, **37**, 36, Wag. Jahr. 1912, **58**, 1, 429, Zts. ang. Chem. 1913, **26**, 27, Zts. Schiess Spreng 1913, **8**, 12.
18. E. P. 17205, 1913, abst. J. S. C. I. 1914, **33**, 943.
19. U. S. P. 1105864, abst. C. A. 1914, **8**, 3237, Chem. Ztg. Rep. 1915, **39**, 350.
20. U. S. P. 946745, 1910. E. P. 23112, 1907, abst. J. S. C. I. 1908, **27**, 421.
21. U. S. P. 1077320, abst. C. A. 1911, **8**, 251. F. P. 463900, 1913.
22. U. S. P. 695129, 1902, abst. J. S. C. I. 1902, **21**, 498.
23. U. S. P. 874264, 874265, 1907.
24. E. P. 1774, 1864.
25. Can. P. 183501, 1918, abst. C. A. 1918, **12**, 1318.
26. Atti Accad. Lincei, 1919, **28**, 1, 393, 428, abst. C. A. 1920, **14**, 1672.
27. D. R. P. 198710, 1907, abst. J. S. C. I. 1908, **27**, 962, Wag. Jahr. 1908, **54**, 1, 157, Zts. ang. Chem. 1908, **21**, 1855, Zts. Schiess Spreng 1908, **3**, 235.
28. Zts. Schiess Spreng 1914, **9**, 96, abst. C. A. 1914, **8**, 9871.

Nitrocellulose in Cartridge Manufacture. In the manufacture of blasting and mining cartridges, ordnance projectiles, torpedoes, nitro cotton has been used to a comparatively limited extent. This art in its development and perfection, is indicated in the ideas and inventions of P. Boca,¹ A. Nobel,² C. Claessen,³ C. Curtis, D. Metcalfe and A. Percy,⁴ L. de Froideville,⁵ W. Fuller,⁶ C. Galand,⁷ H. Garrett and G. Holcroft,⁸ F. Glaser,⁹ T. Henderson,¹⁰ D. Hickie and F. Beutner,¹¹ J. Lemoine,¹² H. Luttke,¹³ J. Macintosh,¹⁴ H. Maxim,¹⁵ H. Maxim and R. Symon,¹⁶ Patent Oxonite Co. and R. Punshon,¹⁷ Patterson,¹⁸ E. Pachtmann,¹⁹ E. Potter and J. Pomeroy,²⁰ F. Prince,²¹ E. Prentice,²² E. Reuss,²³ J. Revy,²⁴ J. Rigby,²⁵ T. Shaffner,²⁶ Soc. Anon. des Explosifs de

20. E. P. Appl. 21647, 1919; abst. J. S. C. I. 1919, **38**, 701-A.

30. E. P. 12536, 1901; abst. Arms & Explo. 1901, **9**, 130. India P. Appl. 473, 1903.

1. E. P. 5722, 1883.

2. E. P. 12307, 1889. See also E. P. 1988, 1889.

3. E. P. 12346, 16456, 1913; abst. J. S. C. I. 1914, **33**, 845. F. P. 459979, and addition 17491, 1913, abst. C. A. 1914, **8**, 3238; J. S. C. I. 1914, **33**, 44, 845; Chem. Ztg. Rep. 1914, **38**, 446. D. R. P. 289446; abst. C. A. 1916, **10**, 2800; Chem. Zentr. 1916, **87**, I, 240; Chem. Ztg. Rep. 1916, **40**, 79; Wag. Jahr. 1916, **62**, I, 253. D. R. P. 288655; abst. Chem. Ztg. Rep. 1915, **39**, 497; Wag. Jahr. 1916, **62**, I, 253.

4. E. P. 6756, 12404, 1898; abst. J. S. C. I. 1899, **18**, 400, 706.

5. E. P. 1275, 1874.

6. U. S. P. 386875, 1888.

7. E. P. 2695, 1866.

8. E. P. 2923, 1867.

9. E. P. 17167, 1887; 2078, 13442, 1889; 23105, 1892; abst. J. S. C. I. 1889, **8**, 166, 1032; 1890, **9**, 215; 1892, **11**, 1056; 1893, **12**, 1057. F. P. 185051, 1887; abst. Mon. Sci. 1888, **32**, 756.

10. E. P. 1255, 1859.

11. E. P. 12649, 1894; abst. J. S. C. I. 1894, **13**, 782; 1895, **14**, 540. E. P. 6105, 1895. D. R. P. 88301; abst. Wag. Jahr. 1896, **42**, 422; Zts. ang. Chem. 1896, **9**, 732. See also F. Hurd, E. P. 3474, 1880.

12. E. P. 432, 1862.

13. E. P. 768, 1903; abst. J. S. C. I. 1903, **22**, 380.

14. E. P. 2759, 1859; 1295, 1860; 3325, 1866.

15. E. P. 17994, 1894; abst. J. S. C. I. 1894, **13**, 1010; 1895, **14**, 788, 820. E. P. 11299, 1895; abst. J. S. C. I. 1897, **16**, 498.

16. E. P. 4780 1893. See also H. Maxim, E. P. 28376, 1904; abst. J. S. C. I. 1905, **24**, 457.

17. E. P. 15094, 1885; abst. J. S. C. I. 1885, **4**, 746; 1886, **5**, 46.

18. Glasgow Phil. Soc., March 28, 1870; abst. Chem. News, Amer. Reprint, 1870, **6**, 326.

19. E. P. 17020, 1889.

20. E. P. 679, 1862.

21. E. P. 173, 1855.

22. E. P. 3127, 1867.

23. E. P. 4926, 1878.

24. E. P. 2720, 1863; 1300, 1865.

25. E. P. 7911, 1886; abst. J. S. C. I. 1886, **5**, 398; 1887, **6**, 314.

26. U. S. P. 93757, 1869.

Clement Muller & Co.,¹ Stork & Co.,² E. Thorn,³ A. Tronchon,⁴ E. Turpin,⁵ Westfälisch-Anhaltische Sprengstoff Act.-Ges.,⁶ L. Wohler,⁷ J. Burrige,⁸ and E. Bergerat.⁹

For coating cartridges, the methods of M. Tweedie,¹⁰ G. Quick,¹¹ and R. Punshon¹² may be consulted.

In the preparation of powder bags and powder cases, cartridge cases, and envelopes for ordnance charges, nitrocellulose has been used considerably. Details of this branch are to be found in the methods of F. Timmel,¹³ O. Thiele,¹⁴ F. Krupp,¹⁵ L. Bruen,¹⁶ E. Bouchaud-Praceiq,¹⁷ F. Bolton,¹⁸ Albrecht,¹⁹ J. Bakewell,²⁰ and A. Barrallon.²¹

The formation of detonators, ignition and blasting fuses, primers, percussion caps and patch cords is a field of usefulness in which guncotton has largely entered. Details of the various methods of application along these lines are to be found in the ideas and processes of A. Zernander,²² Winchester Repeating Arms Co.,²³ J. Watson,²⁴ M. Wagner,²⁵ I. Tice,²⁶ S. Taylor,²⁷ M. Swope,²⁸

1. Belg. P. 243928, 1912
2. F. P. 97175, 1872
3. E. P. 15084, 1893
4. E. P. 1002, 1867
5. E. P. 1461, 1882; abst. J. S. C. I. 1884, **3**, 536; E. P. 15080, 1885; abst. J. S. C. I. 1885, **4**, 762, 1886, **5**, 46, 679
6. E. P. 2225, 1898; abst. J. S. C. I. 1898, **17**, 488; D. R. P. 108708; abst. Chem. Centr. 1900, **71**, 1, 115; Wag. Jahr. 1900, **46**, 1, 403, Zts. ang. Chem. 1900, **13**, 330
7. E. P. 21065, 1900.
8. E. P. 3760, 1877.
9. E. P. 7324, 1892
10. E. P. 24275, 1897
11. E. P. 5508, 1886, 17506, 1887.
12. E. P. 2242, 1880; abst. J. A. C. S. 1881, **3**, 178; Chem. Ind. 1882, **4**, 123; Wag. Jahr. 1881, **27**, 330
13. E. P. 2592, 1903; abst. J. S. C. I. 1903, **22**, 572.
14. E. P. 13823, 1894.
15. E. P. 6103, 1902; abst. Arms & Explo. 1903, **11**, 17
16. E. P. 1216, 1867; 12743, 1887.
17. F. P. 413821, 445770; abst. C. A. 1913, **7**, 1976; J. S. C. I. 1912, **31**, 1203; Chem. Ztg. Rep. 1913, **37**, 114.
18. E. P. 6501, 1885.
19. E. P. 130410, 1919; abst. J. S. C. I. 1919, **38**, 610-A.
20. E. P. 27200, 1896.
21. E. P. 14861, 1902. D. R. P. 146538; abst. Wag. Jahr. 1904, **50**, 11, 511.
22. E. P. 14320, 1896; abst. Arms & Explo. 1897, **5**, 185; J. S. C. I. 1896, **15**, 576; 1897, **16**, 582, 634.
23. E. P. 15410, 1910.
24. E. P. 25058, 1894; abst. J. S. C. I. 1895, **14**, 100, 1008, 1896, **15**, 51.
25. E. P. 7711, 1896. See also E. Reuss, E. P. 4920, 1878.
26. U. S. P. 38994, 1863.
27. E. P. 11994, 1847.

- F. Smith,¹ T. Schulhof and Quirin,² O. von Schroetter,³ W. Reid and E. Earle,⁴ S. Mackie, C. Faure and G. Trench,⁵ J. Loader,⁶ R. Linke,⁷ W. Leonard,⁸ F. Krupp,⁹ King's Norton Metal Co., H. Smith and H. Brownsdon,¹⁰ W. Hudson,¹¹ Westfälisch-Anhaltische Sprengstoff Act.-Ges.,¹² J. Hubner,¹³ F. Hale and G. Bell,¹⁴ G. Elia,¹⁵ Explosivstoff-Werke Spiralit Ges. and M. Thorn,¹⁶ E. Dumas,¹⁷ W. Cronquist and C. Lundholm,¹⁸ Courvoisier,¹⁹ J. Chandor,²⁰ W. Buell,²¹ P. Brighenti,²² G. Bousfield,²³ and J. Bickford and Bickford, Smith & Co.²⁴

The patented processes of L. Carre,²⁵ and of W. Pierson²⁶ are

- 28 U. S. P. 1073941, abst. C. A. 1913, **7**, 3842, J. S. C. I. 1913, **32**, 992 U. S. P. 1194095, abst. C. A. 1916, **10**, 2525, J. S. C. I. 1916, **35**, 980, Mon. Sci. 1917, **84**, 61
- 1 E. P. 1755, 1891, abst. Arms & Explo. 1895, **3**, 123, J. S. C. I. 1894, **13**, 194, 1895, **14**, 332
- 2 E. P. 4917, 1882, abst. Wag. Jahr. 1884, **30**, 377, E. P. 161084, 1884, abst. Mon. Sci. 1884, **26**, 911
- 3 U. S. P. 908149, abst. C. A. 1900, **3**, 956, Zts. Schiess. Spreng. 1909, **4**, 194 E. P. 8156, 8157, 1907, abst. C. A. 1907, **1**, 2511, J. S. C. I. 1907, **26**, 893, Zts. Schiess. Spreng. 1907, **2**, 413 E. P. 376339, 376340, abst. J. S. C. I. 1907, **26**, 991
- 4 E. P. 26893, 1898, abst. Arms & Explo. 1899, **7**, 195
- 5 E. P. 198, 1877
- 6 E. P. 3373, 1870
- 7 E. P. 2592, 1897
- 8 E. P. 3717, 1874
- 9 E. P. 2575, 1896, abst. J. S. C. I. 1896, **15**, 152, 236, 376 E. P. 6103, 1902 E. P. 3388, 1913
- 10 E. P. 23819, 1907, abst. Mon. Sci. 1912, **77**, 81, Chem. Ztg. Rep. 1909, **33**, 195
- 11 U. S. P. 1329525, 1920, abst. J. S. C. I. 1920, **39**, 249-A.
- 12 E. P. 2225, 1898, abst. J. S. C. I. 1898, **17**, 488
- 13 E. P. 16668, 1901, abst. J. S. C. I. 1902, **21**, 1246 See also G. Hubner, E. P. 19299, 1894, abst. J. S. C. I. 1894, **13**, 1010, 1120, 1895, **14**, 66.
- 14 E. P. 13348, 1902, abst. J. S. C. I. 1903, **22**, 441
- 15 E. P. 1316, 1913
- 16 E. P. 8250, 1898
- 17 E. P. 12111, 1887, abst. J. S. C. I. 1887, **6**, 620, 1888, **7**, 537, 540. See also A. Dumas, E. P. 2100, 1864
- 18 E. P. 15993, 1886, abst. J. S. C. I. 1887, **6**, 691, 692
- 19 E. P. 96530, abst. Bull. Soc. Chim. 1874, **21**, 192, Wag. Jahr. 1874, **20**, 425
- 20 E. P. 3717, 1874.
- 21 U. S. P. 1106343, abst. C. A. 1914, **8**, 3238, Mon. Sci. 1914, **81**, 188. U. S. P. 1174669, abst. C. A. 1916, **10**, 1435; J. S. C. I. 1916, **35**, 490, Mon. Sci. 1917, **84**, 56 E. P. 21082, 1914; abst. J. S. C. I. 1915, **34**, 1169.
- 22 E. P. 340790, 1904.
- 23 E. P. 2882, 1857.
- 24 U. S. P. 47677, 1865. E. P. 12111, 1887, abst. Wag. Jahr. 1889, **35**, 481, J. S. C. I. 1887, **6**, 620, 1888, **7**, 537, 540.
- 25 E. P. 117, 1908; abst. J. S. C. I. 1909, **28**, 162
- 26 U. S. P. 1138146, 1915, abst. J. S. C. I. 1915, **34**, 688; C. A. 1915, **9**, 1692

for the use of nitrocellulose for matches and match head compositions. In fireworks, pyrotechnics generally, and flash light compositions, the processes of G. Krebs,¹ V. Schwartz,² C. Brunot,³ and F. Fredureau and H. de Chavannes,⁴ are indicative. The O. v. Schroetter process⁵ is for detonating charges of wet "pyroxylated" powders.

In nitrocellulose smokeless powders, various methods have been proposed for diminishing or eliminating the flame, and decreasing the noxious fumes. These processes are embodied in the inventions of J. Westerman,⁶ A. Cocking and Kynoch, Ltd.,⁷ R. Punshon,⁸ H. Walker,⁹ Westfalsch-Anhaltische Sprengstoff-Akt-Ges.,¹⁰ H. Maxim,¹¹ Delpech,¹² A. O'Neil,¹³ J. Lux,¹⁴ S. Howell,¹⁵ J. Holmes,¹⁶ Societe d'Etudes Chim. pour l'Industrie,¹⁷ H. Krukopf,¹⁸ G. Hosie,¹⁹ C. Duttenhofer,²⁰ J. Ephraim,²¹ K. Pflug,²² S.

1. E. P. 20117, 1901, abst. J. S. C. I. 1902, **21**, 1348.
2. E. P. 5637, 1896.
3. E. P. 5415, 1896.
4. E. P. 3359, 1865. See also Putz, Phot. Corresp. 1891, 290. R. von Staudenheim, Phot. Corresp. 1891, 186.
5. E. P. 8157, 1907, F. P. 376339, abst. J. S. C. I. 1907, **26**, 893, 991. See also Zts. Ver. Deut. Ing. 1869, 331, Poly. Centr. 1869, **35**, 1193.
6. F. P. 160419, abst. C. A. 1911, **8**, 3380, Chem. Ztg. Rep. 1914, **38**, 390.
7. E. P. 15596, 1905, abst. J. S. C. I. 1906, **25**, 609, Chem. Ztg. 1906, **30**, 487, Zts. Schuss. Spreng. 1906, **1**, 262.
8. E. P. 2867, 1870.
9. E. P. 24002, 1905, abst. J. S. C. I. 1906, **25**, 609, Zts. Schuss. Spreng. 1906, **1**, 345. F. P. 364999, abst. C. A. 1907, **1**, 2960, J. S. C. I. 1906, **25**, 953, Mon. Sci. 1907, **67**, 122.
10. D. R. P. 243846, abst. C. A. 1913, **7**, 893, Chem. Zentr. 1912, **83**, I, 868, Chem. Ztg. Rep. 1912, **36**, 171, Wag. Jah. 1912, **58**, I, 429, Zts. ang. Chem. 1912, **25**, 597, Zts. Schuss. Spreng. 1912, **7**, 99. E. P. 135347, 1903, abst. J. S. C. I. 1904, **23**, 560. F. P. 316569, 1901, abst. J. S. C. I. 1903, **22**, 1308. Cf. E. P. 26617, 1901, 3334, 1902, abst. J. S. C. I. 1902, **21**, 1471, 1903, **22**, 229.
11. U. S. P. 1005632, 1911, abst. J. S. C. I. 1911, **30**, 1281, C. A. 1912, **6**, 294, Mon. Sci. 1912, **77**, 169.
12. Compt. rend. 1919, **169**, 537, abst. J. S. C. I. 1919, **38**, 878.
13. Can. P. 198561, 198562, 1920, abst. C. A. 1920, **14**, 2420. Cf. C. A. 1919, **13**, 2597. See also Anon., Arms & Explo. 1919, **28**, 127, abst. C. A. 1920, **14**, 2418.
14. E. P. 13161, 1895, abst. J. S. C. I. 1895, **14**, 712, 788, 886.
15. Bureau of Mines Tech. Paper No. 100, 1915, abst. C. A. 1915, **9**, 2980. Tech. Paper No. 186, 1918, abst. J. S. C. I. 1918, **37**, 784-A.
16. Explosives Circular No. 3, U. S. Geol. Survey, May 16, 1910. See also C. A. 1909, **3**, 1687, 1910, **4**, 511.
17. E. P. 130166, 1918, abst. J. S. C. I. 1919, **38**, 724-A.
18. E. P. 4592, 1910, abst. J. S. C. I. 1911, **30**, 201.
19. E. P. 3863, 1898, abst. J. S. C. I. 1898, **17**, 297, 300, 976, 1181.
20. E. P. 19408, 1906, abst. C. A. 1907, **1**, 2845, J. S. C. I. 1907, **26**, 1029, Mon. Sci. 1911, **74**, 158, Zts. Schuss. Spreng. 1907, **2**, 436. E. P.

Schilderman,¹ C. Bichel,² J. Hamilton,³ Vereinigte Köln-Rottweiler Pulverfabriken,⁴ Anglo-French F. and S. Ltd., and J. Edwards,⁵ and M. Bielefeldt.⁶

For the above purposes, the sodium, potassium, ammonium, magnesium and barium salts of acetic, boric, citric, oxalic, carbonic and tartaric acids have been found most beneficial, being reduced to an impalpable powder and then mixed with the other ingredients in the powder composition. Urea oxalate has also been proposed as a useful product to eliminate muzzle fire.

For decreasing the relative insensibility to shock, modifying the velocity of burning, regulating the explosive action and sensitiveness, and otherwise increasing the stability and permanency of nitrocellulose smokeless powders, a variety of suggestions have been made, additions to the powder proposed, and formulas evolved, particulars of which are contained in the processes of Zentralstelle für wissenschaftliche-technische Untersuchungen G. m. b. H.,⁷ R. Punshon,⁸ R. Brown,⁹ R. Hodgkinson,¹⁰ F. Krupp,¹¹ 791, 1907; abst. C. A. 1907, **1**, 2506; J. S. C. I. 1907, **26**, 840; F. P. 364413 and addition 6620, 1906; abst. J. S. C. I. 1907, **26**, 1107. See also E. P. 24782, 1904; abst. J. S. C. I. 1905, **24**, 105; Mon. Sci. 1907, **67**, 107; Chem. Ztg. Rep. 1906, **30**, 254.

21. D. R. P. 175399; abst. Chem. Centr. 1906, **77**, II, 1702; Wag. Jahr. 1906, **52**, I, 477; Zts. Schiess. Spreng. 1906, **1**, 364. D. R. P. 195486, abst. Chem. Ztg. Rep. 1908, **32**, 185; Jahr. Chem. 1905-1908, II, 981; Wag. Jahr. 1908, **54**, I, 436; Zts. ang. Chem. 1908, **21**, 842; Zts. Schiess. Spreng. 1908, **3**, 93.

22. D. R. P. 125098; abst. Chem. Centr. 1901, **72**, II, 1140; Chem. Ztg. 1901, **25**, 1019; Chem. Zts. 1902, **1**, 255; Jahr. Chem. 1901, **54**, 896; Wag. Jahr. 1901, **47**, I, 490; Zts. ang. Chem. 1901, **14**, 1213.

1. Zts. Schiess. Spreng. 1913, **8**, 126; abst. J. S. C. I. 1913, **32**, 453.

2. E. P. 5791, 1903; abst. Arms & Explo. 1904, **12**, 28; J. S. C. I. 1904, **23**, 130; Mon. Sci. 1905, **63**, 67; Chem. Ztg. 1904, **28**, 691. F. P. 327888, 1902; U. S. P. 877027, 1908; abst. J. S. C. I. 1903, **22**, 963; 1908, **27**, 593; Chem. Zts. 1903, **2**, 613, 715; Mon. Sci. 1905, **63**, 84.

3. E. P. 22162, 1896; abst. J. S. C. I. 1896, **15**, 764; 1897, **16**, 716, 825; Mon. Sci. 1898, **52**, 178; Chem. Ztg. Rep. 1898, **22**, 189.

4. D. R. P. 195486; abst. Chem. Ztg. Rep. 1908, **32**, 185; Jahr. Chem. 1905-1908, II, 981; Wag. Jahr. 1908, **54**, I, 436; Zts. ang. Chem. 1908, **21**, 842; Zts. Schiess. Spreng. 1908, **3**, 93.

5. E. P. 24025, 1907; abst. J. S. C. I. 1909, **28**, 221. E. P. 24327, 1907; 12158, 1908; abst. C. A. 1909, **3**, 1929; J. S. C. I. 1909, **28**, 222; Zts. Schiess. Spreng. 1909, **4**, 137.

6. E. P. 20216, 1903; abst. J. S. C. I. 1904, **23**, 836. F. P. 335801; abst. J. S. C. I. 1904, **23**, 269; Mon. Sci. 1905, **63**, 85.

7. D. R. P. 298539, 1916; abst. J. S. C. I. 1920, **39**, 249-A; Chem. Zentr. 1919, **90**, IV, 942.

8. F. P. 91749. E. P. 2867, 1870; see Ber. 1872, **5**, 739; Wag. Jahr. 1872, **18**, 299. E. P. 4268, 1875. E. P. 2242, 1880; abst. J. A. C. S. 1881, **3**, 178; Chem. Ind. 1883, **4**, 123; Wag. Jahr. 1881, **27**, 330. See Les Mondes, 1872, **27**, 289; **29**, 554. The Athenaeum, Feb. 3, 1872.

• E. Prentice,¹ F. Jones,² J. McNab and R. Jenkins,³ P. Corbin,⁴
 • C. Bichel,⁵ W. Anderson,⁶ and others.⁷

• The specifications and special tests for smokeless powders as distinguished from nitrocellulose; theory, physics and ballistics of nitrocellulose powders; standardization of propellant and eruptive nitrocellulose compositions; temperatures of explosion of exothermic bodies; factors limiting the maximum pressures developed in gaseous explosions; combustion of colloidal powders; and the temperature of explosions, are topics of paramount importance, but which are difficult to deal with in an abstract manner. Full information will be found by consulting the writings of C. Waller,⁸ M. Lloyd,⁹ A. Dierona,¹⁰ R. Datta and N. Chatterjee,¹¹ W. David,¹² E. Mann and T. Kirtou,¹³ A. Djeinem,¹⁴ C. Storm,¹⁵ "P. N.,"¹⁶ Alger,¹⁷ B. Bourgoïn,¹⁸ J. Berkhout,¹⁹ K. von Baltz,²⁰

9. E. P. 11458, 1894, abst. *Arms & Explo.* 1895, **3**, 162; J. S. C. I. 1894, **13**, 688; 1895, **14**, 418, 596; *Mon. Sci.* 1896, **43**, 64.
10. E. P. 17450, 1888, abst. J. S. C. I. 1888, **7**, 884, 1889, **8**, 946, 1890, **9**, 67, 105. See also F. Nathan, W. Rintoul and F. Baker, E. P. 12742, 12743, 12744, 12745, 12746, 1912, abst. J. S. C. I. 1913, **32**, 991.
11. E. P. 6103, 1902.
12. E. P. 953, 1896.
13. Can. P. 55642, 1897. U. S. P. 625682. E. P. 1154, 1897; abst. J. S. C. I. 1897, **16**, 84, 382, 561. E. P. 15553, 1898, abst. *Arms & Explo.* 1899, **7**, 145; J. S. C. I. 1898, **17**, 721, 1899, **18**, 732, 858; *Mon. Sci.* 1900, **56**, 131. D. P. 120201; abst. *Mon. Sci.* 1901, **57**, 218; *Chem. Ztg.* 1901, **25**, 402; *Wag. Jahr.* 1901, **47**, I, 491; *Zts. ang. Chem.* 1901, **14**, 625.
14. E. P. 1341, 1881. See also E. P. 3150, 1876.
15. U. S. P. 1041745, 1912; abst. C. A. 1912, **6**, 3525; *Mon. Sci.* 1913, **79**, 148; *Zts. Schiess. Spreng.* 1913, **8**, 179.
16. F. P. 356864, 1905, abst. C. A. 1907, **1**, 1325, 1344; *Mon. Sci.* 1907, **67**, 10.
17. E. P. 28544, 1908; abst. C. A. 1910, **4**, 2206; J. S. C. I. 1910, **29**, 178; *Zts. Schiess. Spreng.* 1910, **5**, 196.
18. "Commandant A. R.," *Proc. U. S. Nav. Inst.* 1917, **43**, No. 4. L. Poncet, *J. Roy. U. S. Inst.* 1898, **42**, 1424. Committee of Fire Prevention and National Standards (pamphlet), abst. C. A. 1920, **14**, 2419. G. Weissenberger, *Zts. Schiess. Spreng.* 1920, **15**, 33, abst. C. A. 1920, **14**, 2419.
19. *J. Ind. Eng. Chem.* 1918, **10**, 448; abst. J. S. C. I. 1918, **37**, 487. A.
20. Seventh Inter. Cong. Appl. Chem. 1909, III-b, 94. See also *Arms & Explo.* 1904, **12**, 22.
21. Atti. R. accad. Lincei, 1918, **27**, II, 52; J. S. C. I. 1918, **37**, 749. A; abst. C. A. 1919, **13**, 789.
22. J. C. S. 1919, **115**, 1006, abst. J. S. C. I. 1919, **38**, 879.
23. *Engineering*, 1919, **108**, 251.
24. Special Report, Insp. of Expl. Western Australia, 1918; abst. C. A. 1919, **13**, 2445.
25. *Rec. chim. ind.* 1918, **27**, 264; abst. C. A. 1919, **13**, 1391. See also *Chem. Trade J.* Dec. 27, 1913, abst. J. S. C. I. 1914, **33**, 103; C. A. 1914, **8**, 1505.
26. Bureau of Mines Bull. No. 96 (1916); abst. C. A. 1916, **10**, 1929.
27. *Proc. U. S. Nav. Inst.* **38**, 789, abst. C. A. 1912, **6**, 2531. See also

- Beyling,¹ J. Olsen,² H. Rebenstorff,³ M. Watteyne,⁴ F. Jones,⁵
 • R. Cooper-Key,⁶ P. Siwy,⁷ P. Rusch,⁸ M. Marquoyrol,⁹ C. Vol-
 ney,¹⁰ P. Busch,¹¹ Darapsky,¹² W. Snelling and C. Storm,¹³ E.
 Pothier,¹⁴ H. Yarnall,¹⁵ Guilbaud,¹⁶ G. Baird,¹⁷ F. Heise,¹⁸ J. Hen-
 derson and T. McCall,¹⁹ C. Herlin,²⁰ F. Hess,²¹ S. Spddy,²² Dau-
 triche,²³ W. Macnab and E. Ristori,²⁴ Burkhardt,²⁵ L. Karolyi,²⁶
 R. Griffith,²⁷ H. Howe,²⁸ and C. Munroe.²⁹
- Mem poud salp 1911, **16**, 21, abst C A 1912, **6**, 933
 17. Zts Schiess Spreng, 1912, **7**, 13
 18. Rev gén sci 1907, **18**, 93; 1913, **24**, 646-886
 19. Zts Schiess Spreng 1912, **7**, 67, abst Wag Jahr 1912, **58**, I, 444
 20. Zts Schiess Spreng 1911, **6**, 330, abst C A 1911, **5**, 3910
 1. Gluckauf, 1903, **39**, 434, Chem Ztg Rep 1903, **27**, 149; abst J S.
 C I. 1903, **22**, 820
 2. Polytechn Eng **12**, 47, abst C A 1912, **6**, 3521
 3. Zts Schiess Spreng 1908, **3**, 45, Zts physiol Chem 1908, **20**, 388,
 • abst Wag Jahr 1908, **54**, I, 453, C A 1908, **2**, 2992
 4. Arms & Explo 1898, **6**, 59.
 5. Arms & Explo 1904, **12**, 122
 6. Arms & Explo 1899, **7**, 45. See also Winkhaus, Arms & Explo.
 1895, **3**, 7
 7. Zts. Schiess Spreng 1908, **3**, 41, 1910, **5**, 331; abst C. A. 1908, **2**,
 2862, 1911, **5**, 383
 8. Zts Schiess Spreng 1911, **6**, 253, abst C A 1911, **5**, 3910
 9. Ann. Chim. anal. 1911, **16**, 209, abst J S C I 1911, **30**, 835,
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 10. U S P 125635, 1872
 11. Mitt Seewesen, Jan 1909, abst Wag Jahr 1909, **55**, I, 437. See
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 12. Dingt Poly 1869, **192**, 165, Poly Centr 1869, **35**, 1193; Poly
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 257. Deut Industrieztg 1869, 178, Wicke's Gewerbeztg 1869, 178, Arch
 f. Seew 1869, 196
 13. Bull 51, Dept Inter Bureau of Mines, 1913
 14. Compt rend. 1880, **90**, 1348, abst Jahr Chem 1880, **33**, 1308.
 15. Zts Schiess Spreng 1911, **6**, 193, J Amer Soc Nav. Eng. May,
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 16. Compt rend. 1915, **161**, 212, abst C A 1915, **9**, 2982
 17. J. Amer Soc Nav Eng **23**, 838, abst C A 1912, **6**, 293
 18. Zts Schiess Spreng 1914, **9**, 225, abst C A 1914, **8**, 3121.
 19. J S C I 1910, **29**, 242, abst Wag Jahr 1910, **56**, I, 499
 20. Zts Schiess Spreng 1914, **9**, 236. See also C A. 1914, **8**, 823
 21. Zts anal Chem 1880, **19**, 502. See also Chem Tech. Rep. 1878,
17, I, 411, 538.
 22. Arms & Explo 1912, **20**, 22, abst C A 1912, **6**, 931. See also
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 23. Mem poud. salp 1907-8, **14**, 5; abst J S C I 1908, **27**, 593.
 24. Mitth Gegenst Artill Geniew 1894, 93, abst. Wag. Jahr. 1895, **41**,
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 25. Berggeist, 1872, 507, 523, 537, 547, 614; abst Chem. Centr. 1873,
44, 41; Wag. Jahr. 1873, **19**, 333.
 26. Les Mondes, 1864, **5**, 742
 27. Arms & Explo 1896, **4**, 165
 28. Bull Soc Entour 1918, **129**, 284, abst Chem Zentr. 1919, **90**, II, 200
 29. J. A. C S 1884, **6**, 13, abst Wag Jahr 1884, **30**, 372.

Carbohydrate Carboxylates. *Section Eleven.* The subject-matter involved in the historical development of the carbohydrate carboxylates, is divided herein in manner as follows:

1. *Cellulose Acetates* (2987).
2. *Raw Materials*, synthetic acetic acid (2994), acetaldehyde (2994), properties of acetic acid (2998), acetic anhydride (3000), formic acid (3002).
3. *Manufacture of Acetated Cellulose* (3005).
 1. *Cellulose Formate* (3015).
 5. *Cellulose Aceto-nitrates* (3019).
 6. *Cellulose Acetate Solvents and Plastics* (3022).
 7. *Commercial Applications* (3011), airplane lacquers (3046), artificial filaments (3052), dyeing cellulose acetate (3055).

Cellulose Acetates. The first record of an acetylated carbohydrate is found in the memoirs of P. Schutzenberger in 1862,¹ this investigation being followed by the work of A. Girard,² C. Liebermann and O. Hoernmann,³ A. Franchimont,⁴ C. Guignet,⁵

1. Compt rend 1865, **61**, 185, 186, abst Bull Soc Chim 1866, (2), **5**, 291, Zts. Chem 1866, **9**, 16, Chem Centr 1865, **36**, 1036, J. pr. Chem 1866, **97**, 250, J. pharm. chim 1865, (4), **2**, 376, Jahr. Chem 1865, **18**, 594, Ber 1869, **2**, 163, 556. Compt rend 1869 **68**, 814, abst Chem Centr 1869, **11**, 681, Zts. Chem 1869, **12**, 261, Bull. Soc Chim 1868, (2), **10**, 178, 1869, (2), **12**, 107, 204, Jahr. Chem 1869, **22**, 750. Ann Chim Phys 1870, (4), **21**, 235-64, abst Chem Centr 1871, **42**, 568, reproduced Ann Chim Pharm 1871, **160**, 74-100, abst J. C. S. 1872, **25**, 366, Chem Centr 1871, **42**, 710.

2. Compt rend 1875, **81**, 1105, abst Ber 1876, **9**, 65, Jahr. Chem 1875, **28**, 786, Chem Centr 1876, **47**, 83, J. C. S. 1876, **30**, i, 676, Chem News, 1875, **33**, 10. Ann Chim Phys 1876, (5), **9**, 116, abst Chem Centr 1877, **48**, 6. Compt rend 1879, **89**, 170, abst Jahr. Chem 1879, **32**, 1776. Compt rend 1879, **88**, 1322, abst Ber 1879, **12**, 2085, 2158, Jahr. Chem 1879, **32**, 835, Jour. de Pharm. 1879, **30**, 348, J. C. S. 1879, **36**, 779. Ann Chim Phys 1881, (5), **24**, 337, abst Ber 1881, **14**, 2834, Jahr. Chem 1881, **34**, II, 985, J. C. S. 1882, **42**, 378. For "Conversion of Hydrocellulose into Pyroxylin," see Girard, Compt. rend 1879, **89**, 170, abst J. C. S. 1879, **36**, 911. Same as Bull. Soc. d'Encour. (3), **8**, No. 91, abst Chem News, 1881, **44**, 216. For life of A. Girard, see M. L. Lundet, Bull. Soc. Chim 1898, (3), **20**, I-XXVI, with bibliography.

3. Ber 1878, **11**, 1618, abst J. C. S. 1879, **36**, 271, Bull. Soc. Chim 1879, **32**, 338, Jahr. Chem 1878, **31**, 92, Chem Centr 1878, **49**, 710.

4. Rec. Trav. Chim 1899, (2), **18**, 465, 472, abst J. C. S. 1900, **78**, i, 141; Jahr. Chem 1899, **52**, 1289. Rec. Trav. Chim 1883, **2**, 241, abst Jahr. Chem 1883, **36**, 1366, Chem Centr 1884, **55**, 60. Compt rend 1881, **92**, 1053, abst Chem Centr 1881, **52**, 424, Jahr. Chem 1881, **34**, 985, J. C. S. 1881, **40**, 709, Ber 1881, **14**, 1290. Compt rend 1881, **92**, 1054, abst Chem Centr 1881, **52**, 422, Jahr. Chem 1881, **34**, 859, J. C. S. 1881, **39**, 716, Ber 1881, **14**, 1284. Compt rend 1879, **89**, 711, abst J. C. S. 1880, **38**, 159; Chem. Centr. 1879, **50**, 771. Reproduced Ber 1879, **12**, 1938.

5. Compt rend 1889, **108**, 1258, abst Jahr. Chem 1889, **42**, 2839; Ber 1889, **22**, 574, Chem Centr 1889, **60**, II, 124, J. C. S. 1889, **51**, 847; Chem. News, 1889, **60**, 24.

E. Erwig and W. Koenigs,¹ C. Cross and E. Bevan,² C. Wetzel,³ J. Thiele,⁴ Z. Skraup,⁵ L. Vignon and F. Gerin,⁶ C. Bady,⁷ H. Ost,⁸ F. Marsden,⁹ C. Haussermann,¹⁰ E. v. Hardt-Stramayr,¹¹ E. Knoevenagel,¹² A. Smith and K. Orton,¹³ A. Green and A.

1. Ber. 1889, **22**, 1457; abst. J. S. C. I. 1889, **3**, 723; Jahr. Chem. 1889, **42**, 1692; J. C. S. 1889, **56**, 991; Chem. Centr. 1889, **60**, II, 251. Ber. 1889, **22**, 1464; abst. J. S. C. I. 1889, **3**, 718; Jahr. Chem. 1889, **42**, 2041; J. C. S. 1889, **56**, 952; Chem. Centr. 1889, **60**, II, 250. Ber. 1889, **22**, 2207; abst. J. S. C. I. 1889, **3**, 994; Jahr. Chem. 1889, 2041; J. C. S. 1889, **56**, 1131; Chem. Centr. 1889, **60**, II, 748. Ber. 1890, **23**, 672; abst. J. S. C. I. 1890, **3**, 637; Jahr. Chem. 1890, **43**, 2132; J. C. S. 1890, **53**, 732; Chem. Centr. 1890, **61**, I, 757.

2. Chem. News, 1889, **50**, 163, 254; abst. Chem. Centr. 1889, **60**, II, 790; 1890, **61**, 21; Jahr. Chem. 1889, **42**, 2066; 1890, 2152. See also Cross and Bevan, J. C. S. 1890, **57**, 2; abst. Chem. Centr. 1890, **61**, I, 390; Amateur Photog. 1899, **30**, 146; Tech. Repert. 1899, 45. For zinc chloride solvent of cellulose, see their Chem. News, 1891, **63**, 66; abst. Chem. Centr. 1891, **62**, I, 534; Jahr. Chem. 1891, **44**, 890; Ber. 1891, **24**, 401. J. C. S. 1904, **85**, 691; abst. Bull. Soc. Chim. 1904, (3), **32**, 1801. E. P. 9676, 1894; abst. J. S. C. I. 1895, **14**, 987; Chem. Centr. 1896, **67**, I, 465.

3. Zts. ang. Chem. 1899, **12**, 5; abst. Proc. Amer. Pharm. Assoc. **48**, 786; Chem. News, 1899, **80**, 247; Jahr. Chem. 1899, **52**, 1289; Wag. Chem. 1899, **45**, 1065; Chem. Centr. 1899, **70**, I, 337.

4. Ber. 1898, **31**, 1247; abst. J. C. S. 1899, **74**, i, 469; Chem. Centr. 1898, **69**, II, 31; Jahr. Chem. 1898, 2010; Bull. Soc. Chim. 1898, (3), **20**, 596. See also Saruw, Ann. 1881, **209**, 129. Buchk, Ber. 1881, **14**, 1327. H. Schultz, Ber. 1882, **15**, 652. Hinsberg, Ber. 1894, **27**, 3259.

5. Monats. 1898, **19**, 458; abst. J. C. S. 1899, **76**, i, 112; Bull. Soc. Chim. 1898, (3), **20**, 898; Jahr. Chem. 1898, **51**, 1123; J. S. C. I. 1898, **17**, 895. Ber. 1899, **32**, 2413; abst. J. C. S. 1899, **76**, i, 852; J. S. C. I. 1899, **18**, 941; Chem. Centr. 1899, **60**, II, 2140; Jahr. Chem. 1899, **52**, 1288; Bull. Soc. Chim. 1900, (3), **24**, 619. Annuario Soc. chim. 1899, 27. Ber. 1901, **34**, 1116; abst. Bull. Soc. Chim. 1902, (3), **28**, 317; Jahr. Chem. 1901, **54**, 878; Chem. Centr. 1901, **72**, I, 1197; J. C. S. 1901, **80**, i, 370.

6. Compt. rend. 1900, **131**, 588; abst. J. S. C. I. 1900, **19**, 1103; J. C. S. 1900, **78**, i, 629; Jahr. Chem. 1900, **53**, 843; Chem. Centr. 1900, **71**, II, 1069; Bull. Soc. Chim. 1901, (3), **25**, 139; abst. Jahr. Chem. 1901, **54**, 891; Fahrerber. Chem. 1901, **2**, 891.

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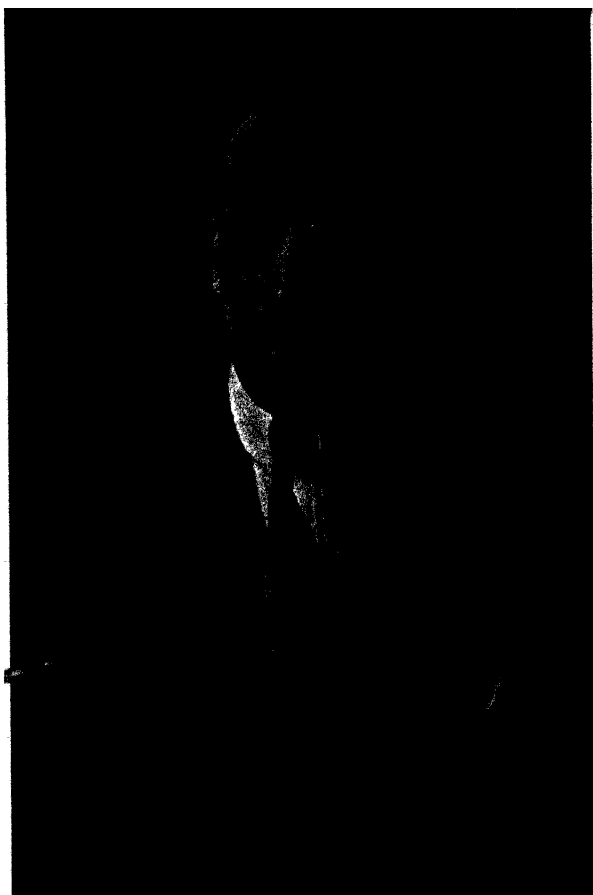
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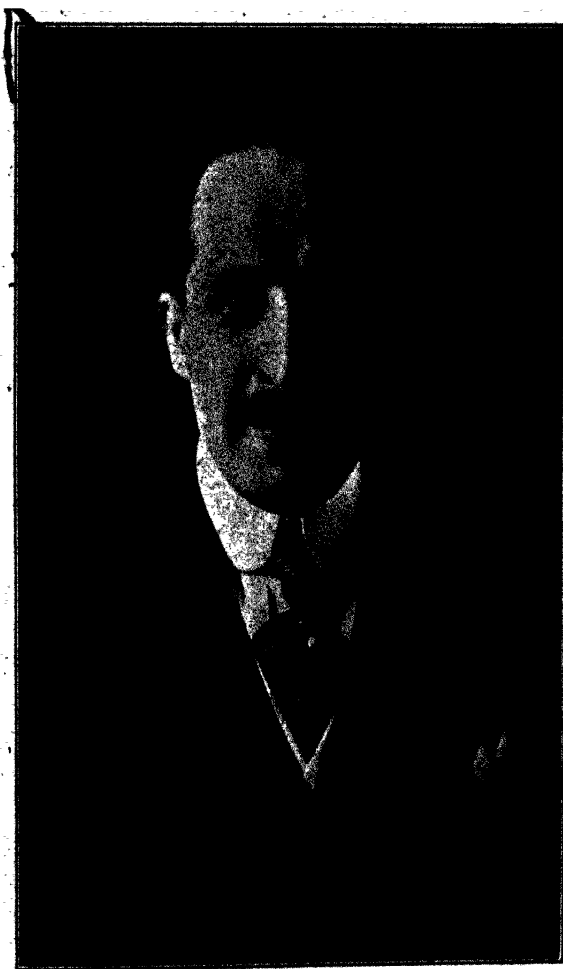
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11. Monats. Chem. 1907, **28**, 73; abst. Bull. Soc. Chim. 1908, (4), **4**, 1. J. C. S. 1907, **92**, i, 359; Zts. ang. Chem. 1908, **21**, 1186; Chem. Centr. 1907, **76**, I, 1571; C. A. 1907, **1**, 2180. Wien. Akad. Ber. **116**, 2-b, 13; Jahr. Chem. 1906-1908, II, 973.

12. Chem. Ztg. 1911, **35**, 248; abst. C. A. 1912, **6**, 1671; Kunst. 1914, **4**, 332. Ann. 1914, **402**, 111; abst. J. S. C. I. 1914, **33**, 102; C. A. 1914, **8**, 913.



Martha Keyser.



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Lerk,¹ A. Green,² A. Eichengruen,³ G. Miles,⁴ C. Schwabe,⁵ W. Main,⁶ F. Fischer,⁷ J. Beltzer,⁸ J. Matthews,⁹ F. Bowman,¹⁰ H. Mork,¹¹ W. Walker,¹² G. Noyer,¹³ L. Clement and C. Riviere,¹⁴ C. Schwalb,¹⁵ A. Stein,¹⁶ Klein,¹⁷ Ost and Katayama,¹⁸ H. Musch-

Zts. ang. Chem. 1914, **27**, I, 505; abst. C. A. 1915, **9**, 524

13. Proc. C. S. 1909, **25**, 166; J. C. S. 1909, **95**, 1060; abst. J. S. C. I. 1909, **28**, 678; Jahr Chem. 1909, **62**, 607; Bull. Soc. Chim. 1909, (4), **6**, 893; Chem. Zentr. 1909, **80**, II, 515.

1. J. C. S. 1906, **89**, 811; abst. Bull. Soc. Chim. 1910, (4), **2**, 37; Jahr Chem. 1905-1908, II, **985**; Zts. ang. Chem. 1907, **20**, 459; Chem. Centr. 1906, **77**, II, 321.

2. Zts. Farb. Text. Ind. 1904, **3**, 97; abst. Chem. Centr. 1904, **75**, I, 1069; Jahr. Chem. 1904, **57**, 1160, 1161.

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6. Rev. Scien. 1912, **50**, 783. Chimiste, 1912, **3**, 41, 43; abst. C. A. 1912, **6**, 1849. Compilation. See Marsden, Farb. Ztg. 1906, **42**, 172. Rev. gén. chim. 1915, **13**, 73; abst. C. A. 1915, **9**, 1831. Phot. Mitth. 1890, **36**, 301.

7. Kunst. 1912, **2**, 21, 48, 64; 1914, **4**, 102, 123; abst. C. A. 1912, **6**, 2314; 1914, **8**, 1871; Wag. Jahr. 1912, **58**, II, 445; Zts. ang. Chem. 1912, **25**, 507, 1549; Chem. Tech. Rep. 1912, **36**, 307. Compilation of 235 cellulose ester patents chronologically arranged.

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9. "The Textile Fibers," 1913, 221.

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11. Original Communication, 8th Inter. Cong. Appl. Chem. **13**, 195; abst. C. A. 1912, **6**, 3013; Kunst. 1913, **3**, 273.

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14. Original Communication, 8th Inter. Cong. Appl. Chem. **9**, 59; abst. J. S. C. I. 1912, **31**, 869; C. A. 1912, **6**, 3182; Kunst. **2**, 436. Bull. Soc. d'Encour. 1914, **121**, 187; abst. J. S. C. I. 1915, **34**, 75.

15. Zts. ang. Chem. 1908, **21**, 2401; abst. Bull. Soc. Chim. 1909, (4), **6**, 231. Zts. ang. Chem. 1910, **23**, 433; abst. J. C. S. 1910, **88**, i, 224; Bull. Soc. Chim. 1910, (4), **8**, 694. Reproduced, E. Worden, "Nitrocellulose Industry," 1911, **2**, 1937. Zts. ang. Chem. 1911, **24**, 1256; abst. Wag. Jahr. 1911, **57**, II, 504; J. S. C. I. 1910, **29**, 415; 1911, **30**, 948; C. A. 1912, **6**, 42; J. C. S. 1911, **90**, i, 712. In Chem. Ztg. 1910, **34**, 1351, K. Schwalbe recommends hydrolyzed cellulose acetate in solution as a protection of drying cylinders from rust and corrosion.

16. Zts. ang. Chem. 1913, **26**, 673; abst. Kunst. 1914, **4**, 94.

17. Zts. ang. Chem. 1912, **25**, 1409.

18. Zts. ang. Chem. 1912, **25**, 1467.

ner,¹ H. Reeser,² Jdanowich,³ Scott and Tulloch,⁴ O. Silberzad,⁵ Stevenson,⁶ Bindley and Weller,⁷ J. Boeseken, J. v. d. Berg, and A. Kerstjens,⁸ Caldwell,⁹ J. Hardcastle and A. Taylor,¹⁰ W. Wilcox,¹¹ W. Dehn,¹² A. Djeunheim,¹³ A. Dubosc,¹⁴ P. Mork,¹⁵ H. Ost,¹⁶ and G. Esselen.¹⁷

The raw materials required in the acetation of cellulose comprise acetic acid, acetic anhydride and a catalyst. In the preparation of acetic acid the older methods of distillation from an acetate (usually calcium) are indicated in the processes of Aktien Ges. f. Uebertrocknung,¹⁸ P. Adler,¹⁹ A. and J. Behrens,²⁰ F. Bergmann,²¹ P. Boessneck,²² W. Bowers,²³ W. Brandt,²⁴ A. Bräuer,²⁵ L. Brumlen,²⁶

1. Dissertation, Berlin, 1913, 54 pages
2. Elec Eng **44**, 308
3. E. P. Appl 5952, 15163, 1918, abst J. S. C. I. 1918, **37**, 227-A, 611-A.
4. E. P. Appl 24122, 1919, abst J. S. C. I. 1919, **38**, 800-A.
5. E. P. Appl 26969, 1919, abst J. S. C. I. 1919, **38**, 882-A.
6. E. P. Appl 12843, 1917; E. P. 130029, abst J. S. C. I. 1919, **38**, 608-A.
7. E. P. Appl 3502, 3503, 1918, abst J. S. C. I. 1918, **37**, 138-A.
8. Rec trav Chim Pays-Bas, 1916, **35**, 320, abst Chem Zentr 1916, **87**, II, 171, J. S. C. I. 1916, **35**, 320, J. C. S. 1916, **110**, i, 308, C. A. 1917, **11**, 39.
9. E. P. Appl 878, 1917, abst J. S. C. I. 1917, **36**, 9.
10. E. P. 13100, 1914, abst J. S. C. I. 1915, **34**, 146. See J. Reintotter, Kunst 1919, **9**, 185, abst Chem Ztg 1920, **44**, 164.
11. Lancet, 1915, **188**, 544, abst J. S. C. I. 1915, **34**, 508.
12. J. A. C. S. 1912, **34**, 1399, abst J. C. S. 1912, **102**, i, 833.
13. Caout. et Gutta-p 1919, **16**, 9890, abst C. A. 1919, **13**, 3314.
14. Caout et Gutta p 1918, **15**, 9501, abst C. A. 1919, **13**, 660.
15. Paper Makers Monthly J. 1918, **56**, 7; Paper Making, **35**, 372, J. Frank Inst 1918, **184**, 353. J. Ind Eng. Chem. 1919, **11**, 474, C. A. 1919, **13**, 1390.
16. Zts ang. Chem 1919, **32**, 66, 76, 82, abst. C. A. 1919, **13**, 2760. See Ann 1911, **383**, 313, abst C. A. 1913, **7**, 3836. Anon, Chem Trade J. 1918, **63**, 81; abst. C. A. 1918, **12**, 2248. The Little J. 1918, 4. Caout. et Gutta-p: 1918, **15**, 9639. Tech. Mod. 1918, 335. Paper Making, **37**, 245.
17. J. Ind Eng. Chem. 1920, **12**, 801.
18. Aust. P. 880, 1900.
19. Swed. P. 36230, 1912; abst. C. A. 1915, **9**, 1098.
20. E. P. 7301, 1900. A. Behrens, Belg. P. 164245, 1902. J. Behrens, Belg. P. 205071, 1908; U. S. P. 741615, 1903.
21. E. P. 12527, 1895, 5926, 1899.
22. U. S. P. 715748, 1902; abst. J. S. C. I. 1903, **22**, 110. E. P. 25077, 1899. Belg. P. 147574, 1900. Aust. P. 5440, 1901.
23. E. P. 13048, 1899.
24. U. S. P. 737067, 1903; abst. J. S. C. I. 1903, **22**, 1041. Brante & Co., Swiss P. 10049, 1895.
25. U. S. P. 119C329, 1916; abst. C. A. 1916, **10**, 2615; J. S. C. I. 1916, **35**, 1059.
26. U. S. P. 148031, 1874.

C. Burcey,¹ A. Charles,² H. Condry,³ M. Converse,⁴ G. Decat,⁵ E. Dollfuss,⁶ J. DuVivier,⁷ A. Clark,⁸ J. Farmer,⁹ E. French,¹⁰ L. Gale and I. Gattmann,¹¹ A. Clark,¹² H. von Hochstetter,¹³ A. Ippendorf,¹⁴ J. Johnson,¹⁵ T. Jones,¹⁶ F. Jobbins,¹⁷ L. Kraft and H. Sauve,¹⁸ E. Klein,¹⁹ Langwell and Power-Gas Corporation,²⁰ C. von der Linde,²¹ M. and B. Lyster,²² R. MacIvor, F. Darlington, G. Paul and J. Allan,²³ H. McPhail,²⁴ S. Mahood and D. Cable,²⁵ T. Maugham,²⁶ A. Mitscherlich,²⁷ L. Pasteur,²⁸ J. and R. Pickles,²⁹ H. Pierce,³⁰ A. and M. Pirz,³¹ H. Plater-Syberg,³² M. Prager,³³ E. Rotondi and M. Michela,³⁴ J. Schoer,³⁵ Societe E. Barbet et Fils et Cie,³⁶ Serret,³⁷ E. Squibb,³⁸ A. de Saint Yves,³⁹ A. Schmidt,⁴⁰

- 1 U. S. P. 118788, 1871
- 2 F. P. 24965, 24966, 1855
- 3 E. P. 480, 1868, 4037, 1875
- 4 U. S. P. 78264, 1868
- 5 F. P. 55468, 1862
- 6 H. Rothe, Dngl. Poly. 1875, **218**, 317, Deut. Ind. Ztg. 1875, 481, Wag. Jahr. 1875, **21**, 899, Chem. Tech. Rep. 1875, **14**, H. 242
- 7 E. P. 2569, 1889
- 8 E. P. 110, 1878
- 9 U. S. P. 507895, 1893, 540655, 1895, E. P. 13264, 1889
- 10 U. S. P. 1150589, 1915, D. R. P. 249333, 1911, abst. J. S. C. I. 1912, **31**, 914, 1915, **34**, 949
- 11 U. S. P. 93817, 1869
- 12 E. P. 2080, 1881
- 13 Belg. P. 161519, 1902, Aust. P. 12421, 1903
- 14 Belg. P. 168806, 1903
- 15 E. P. 13336, 1887, 17348, 1889, 20955, 1897, 20135, 1899, abst. J. S. C. I. 1890, **9**, 293
- 16 E. P. 1485, 1894
- 17 E. P. 27012, 1898
- 18 E. P. 2432, 1877
- 19 U. S. P. 1291025, 1919, abst. C. A. 1919, **13**, 803
- 20 E. P. Appl. 6778, 1918, abst. J. S. C. I. 1918, **37**, 258 A
- 21 E. P. 3477, 1895
- 22 U. S. P. 952540, 1910, abst. J. S. C. I. 1910, **29**, 552
- 23 E. P. 6815, 1899
- 24 E. P. 23198, 1900
- 25 J. Ind. Eng. Chem. 1919, **11**, 651, abst. C. A. 1919, **13**, 1931
- 26 E. P. 4766, 1881
- 27 E. P. 1665, 1882
- 28 F. P. 50359, 1861
- 29 E. P. 20753, 1891
- 30 U. S. P. 174292, 1876
- 31 U. S. P. 87365, 1869, A. Pirz, U. S. P. 209978, 209979, 1878
- 32 E. P. 233, 1898, Belg. P. 132737, 1897
- 33 Belg. P. 250135, 1912, Aust. P. 63534, 1914, Hung. Ann. P. 3748, abst. Chem. Ztg. 1913, **37**, 254
- 34 E. P. 22817, 1892
- 35 F. P. 35002, 1858
- 36 E. P. 120558, 1918, abst. C. A. 1919, **13**, 660
- 37 E. P. Appl. 3086, 1919, abst. J. S. C. I. 1919, **38**, 121 A

A. Scott and T. Henderson,¹ E. Scott,² E. Turpin,³ T. Twynam,⁴ Utheim,⁵ United Alkali Co. and M. Muspratt,⁶ and M. Ziegler.⁷

The recent war brought out methods for the manufacture of "synthetic" acetic acid, wherein entirely inorganic as distinguished from living processes were brought to bear upon the problem. Calcium carbide is converted into acetylene by means of water, the acetylene being then oxidized into acetaldehyde, and this in turn into acetic acid. Many processes and refinements have been brought forward for the production of acetaldehyde, among which may be named those of Cie Urbaine d'Eclairage par le Gaz Acetylene,⁸ M. Jouas, M. Desmonts, L. Deglatigny and L. Dubosc,⁹ C. Kingzett,¹⁰ Society of Chemical Industry in Basle,¹¹ F. Bayer & Co.,¹² J. Behrens,¹³ G. Calvert,¹⁴ Chemische Fabrik Griesheim Elektron,¹⁵ Chem. Fabrik Rhenania, B. Stuer and W. Grob,¹⁶ Consortium f. Elektrochem. Ind.,¹⁷ J.

38. U. S. P. 185141, 1876.

39. E. P. 1215, 1881.

40. E. P. 25100, 1896.

1. E. P. 6711, 1895.

2. E. P. 223, 1898.

3. E. P. 4544, 1881.

4. E. P. 4397, 1881.

5. E. P. 116279, 1918; abst. J. S. C. I. 1919, **38**, 344-A.

6. E. P. 11434, 1899. See E. P. 3477, 1895; 3987, 1896.

7. E. P. 6984, 1898.

8. F. P. 338965, 1903; abst. J. S. C. I. 1904, **23**, 1043. E. L. Rinman, D. R. P. 244816, 1911; abst. J. S. C. I. 1912, **31**, 532; Zts. ang. Chem. 1912, **25**, 1035; Chem. Tech. Rep. 1912, **36**, 249; Wag. Jahr. 1912, **58**, II, 553; Chem. Zentr. 1912, **83**, I, 107. E. French, D. R. P. 249333, 1911; abst. J. S. C. I. 1912, **31**, 914; Zts. ang. Chem. 1912, **25**, 1886; Chem. Zentr. 1912, **83**, II, 465; Chem. Tech. Rep. 1912, **36**, 468; C. A. 1912, **6**, 3181; Wag. Jahr. 1912, **58**, 31.

9. F. P. 360180, 360249, 1905; abst. J. S. C. I. 1906, **25**, 496.

10. J. C. S. 1874, **27**, 511; Chem. Centr. 1874, 566; Jahr. Chem. 1874, **27**, 188; J. C. S. 1875, **28**, 210; Chem. Centr. 1875, **46**, 422; Mon. Sci. (3), **5**, 1020; Jahr. Chem. 1875, **28**, 156; J. C. S. 1880, **37**, 792; Jahr. Chem. 1880, **33**, 248; C. N. 1880, **41**, 254; Chem. Centr. 1881, **52**, 473; J. C. S. 1884, **45**, 93; Jahr. Chem. 1884, **37**, 1272; Chem. Centr. 1884, **55**, 327; Chem. News, **32**, 138; **34**, 127; **35**, 279; J. S. C. I. 1886, **5**, 7; 1888, **7**, 549; 1890, **9**, 3; Chem. Trade Jour. **14**, 115; He has studied the aerial oxidation of the terpenes.

11. U. S. P. 1319365, 1919; E. P. 130138, 1918; abst. J. S. C. I. 1919, **38**, 695-A, 926-A; C. A. 1920, **14**, 72. Swiss P. 78275. F. P. 456571. Can. P. 195354, 1919.

12. D. R. P. 291794.

13. D. R. P. 276764. See D. R. P. Anm. B. 71851, 77452.

14. E. P. 132120, 1918; abst. C. A. 1920, **14**, 284; J. S. C. I. 1919, **38**, 794-A. See E. P. 126479; abst. C. A. 1919, **13**, 2373.

15. E. P. 15669, 1914; F. P. 474246, 1914; Belg. P. 232297, 1911; abst. J. S. C. I. 1915, **34**, 735, 1168. E. P. 143891, 1920. Swiss P. 55931, 1911.

16. E. P. 109983, 1916; abst. J. S. C. I. 1917, **36**, 1194.

17. U. S. P. 1107019, 1914; E. P. 6000, 16848, 17017, 26825, 26826,

Crosfield & Sons and T. Hilditch,¹ G. Crume,² Deutsche Gold und Silber Scheideanstalt,³ H. Dreyfus,⁴ du Pont de Nemours Co.,⁵ Electric Furnace Products Co., Ltd.,⁶ N. Grunstein,⁷ H. Hibbert and H. Morton,⁸ H. Matheson,⁹ Farbwerke vorm. Meister, Lucius & Bruning,¹⁰ Q. Sabatier and G. Gaudion,¹¹ E. Scheller,¹² Selden Co. and H. Gibbs,¹³ T. Shoji,¹⁴ W. Snellhag,¹⁵ Societe des Acierres et Forges de Firminy,¹⁶ Societe Chimique des Usines du Rhone,¹⁷ E. Steinbuch and P. Schetelig,¹⁸ and S. Uthem.¹⁹

- 1913, 7418, 16957, 1914, 5132, 10140, 1915, F. P. 453370, 460553, 160671, 1913; 475183, 1915, D. R. P. Ann. C. 20782, 21950, 22133, 22203, 22298, 22496, 22863, 22527, 23007, D. R. P. 277111, 277188, 285000, 286182, 305125, 309103, 309104, 1916, Belg. P. 254172, 258656, 268811, 1913, Span. P. 50076, 56117, 1913; Swiss P. 74446, 76339, 1918, Ital. P. 131958, 135613, 135776, 1913; Swed. 43001, 1917, abst. C. A. 1914, **6**, 402, 2220, 2023, 1915, **9**, 355, 1917, **11**, 2027, 1918, **12**, 484, 1919, **13**, 2374. J. S. C. I. 1914, **33**, 12, 943, 1913, **32**, 959, 1915, **34**, 735, 888, 1272, Ann. Rep. Soc. Chem. Ind. 1916.
- 1, 272; Chem. Ztg. 1913, **37**, 76, 272. Aust. P. 80901, 1916. Norw. P. Appl. 13856, 1918. Hung. P. Ann. C. 2305, C. 2383, C. 2384, 1913. See also H. Dreyfus, Swiss P. 78947, 1918, abst. C. A. 1919, **38**, 2374.
1. E. P. 124702, 125926, 131084, 1919, abst. C. A. 1919, **13**, 1715, 2218, 1920, **14**, 72, J. S. C. I. 1919, **38**, 274 A, 346 A, 388 A, 440 A, 741 A.
2. U. S. P. 1315543, 1919, abst. C. A. 1919, **13**, 2881, see D. R. P. Ann. C. 20782, 1912.
3. E. P. 107584, 107585, 1917, abst. C. A. 1917, **11**, 2905, J. S. C. I. 1919, **38**, 845 A.
4. U. S. P. 1310743, 1310884, 1919. E. P. 105064, 105065, 106083, 115899, 1917, F. P. 487411, 487412, abst. C. A. 1917, **11**, 2138, 2580, 1918, **12**, 1885, 1919, **15**, 2374, J. S. C. I. 1918, **37**, 222 A, Ind. Chim. 1918, **5**, 261.
5. Belg. P. 250116, 1912.
6. Norw. P. 28537, 1918, abst. C. A. 1918, **12**, 1558.
7. U. S. P. 1044169, 1912, D. R. P. 250356, 253707, 253708, 267260, abst. J. S. C. I. 1912, **31**, 1053, 1147. D. R. P. Ann. G. 31031, G. 31206, G. 33385, Chem. Ztg. 1912, **36**, 528, 1296, 1913, **37**, 1352. See also Zts. ang. Chem. 1919, **32**, I, 396, abst. C. A. 1920, **14**, 1825.
8. U. S. P. 1213486, 1213487, 1247270, 1917, Can. P. 181655, 181656, 181657, 1918, abst. J. S. C. I. 1917, **36**, 403, 1918, **37**, 74 A, C. A. 1918, **12**, 588.
9. E. P. 132557, 132558, 132559, 132560, 1918, abst. J. S. C. I. 1919, **38**, 819 A, 845 A, C. A. 1920, **14**, 288. See E. P. 10140, 1915, abst. C. A. 1917, **11**, 86.
10. U. S. P. 1151928, 1151929, 1915, E. P. 24153, 1914, abst. J. S. C. I. 1915, **34**, 1031.
11. Compt. rend. 1918, **166**, 632, abst. J. S. C. I. 1918, **37**, 322 A.
12. U. S. P. 1244901, 1244902, 1917, abst. C. A. 1918, **12**, 155, J. S. C. I. 1918, **37**, 20 A.
13. E. P. 119517, 119518, 1917, abst. C. A. 1919, **13**, 230.
14. J. Chem. Ind. Japan, 1919, **22**, 28, abst. C. A. 1919, **13**, 1217.
15. U. S. P. 1124347, 1915.
16. E. P. 124194, 124195, 132529, 1919, abst. C. A. 1920, **14**, 284, J. S. C. I. 1920, **39**, 527 A.
17. E. P. 131399, 1918, abst. C. A. 1920, **14**, 284. Cf. E. P. 23190, 1914, 110906; abst. C. A. 1916, **10**, 1407, 1918, **12**, 484.
18. U. S. P. 1319365, abst. C. A. 1920, **14**, 72.
19. Dan. P. 23175, 1918, abst. C. A. 1918, **12**, 2325.

A favorite method consists in oxidizing the acetylene by means of mercuric oxide. The acetaldehyde is then transformed into acetic acid, usually by atmospheric oxidation, aided by a small amount of a salt as manganese acetate. Such processes are described in detail in the methods of Anon.,¹ Societe des Acierrees & Forges de Firminy,² Badische Anilin u Soda Fabrik,³ F. Bayer & Co.,⁴ J. Behrens,⁵ G. Chazel,⁶ Chemische Fabrik Griesheim Elektron,⁷ Consortium für Elektrochemische Industrie,⁸ Compagnie d'Alais et de la Camargue,⁹ H. Dreyfus,¹⁰ J. Garcon,¹¹ N. Grünstein,¹² C. Hansen and A. Weindel,¹³ W. Mamchot,¹⁴ H. Matheson,¹⁵ Farb. v. Meister, Lucius & Brüning,¹⁶ Poore and Sul-

1. Can Chem. J. 1919, **3**, 56, abst. C. A. 1919, **13**, 958. See Zts. ang. Chem. 1918, 180.
2. E. P. Appl. 4018, 1919, abst. J. S. C. I. 1919, **33**, 162-A.
3. D. R. P. 294724, 1914, 296282, abst. C. A. 1917, **11**, 2580; 1919, **13**, 322; J. S. C. I. 1917, **36**, 503.
4. F. P. 467515, 467778, 1914; D. R. P. 293011, 1913; 297442, 1917; 314943, 1916; abst. C. A. 1915, **9**, 1280, 1370; 1917, **11**, 1519; J. S. C. I. 1914, **33**, 830, Chem. Zentr. 1919, **90**, II, 61. D. R. Ann. F-36020.
5. D. R. P. 287360, 293011, 1913, abst. C. A. 1916, **10**, 2127; J. S. C. I. 1916, **35**, 115.
6. Rev. prod. chim. 1918, **21**, 194, abst. C. A. 1919, **13**, 116.
7. E. P. 14113, 1914, F. P. 473158, 1914, Swiss P. 60537, 62720, 1912; 70152, 1915; Belg. P. 243329, 1912; abst. C. A. 1916, **10**, 2388; J. S. C. I. 1915, **34**, 491, 962, Ann. Rep. Soc. Chem. Ind. 1916, **1**, 274. Holl. P. 3679, 1919; abst. C. A. 1920, **14**, 1341. Aust. P. 62490, 1912. D. R. Ann. C-20520, C-20633, C-21425, 1911.
8. E. P. 17015, 1913, 7418, 1914, F. P. 455370, 1913; D. R. P. 277111; 286182, 1914; Belg. P. 258811, 1913; Aust. P. 71348, 1916; abst. C. A. 1915, **9**, 2424; 1916, **10**, 2503; J. S. C. I. 1913, **32**, 959, 1914, **33**, 42; 1915, **34**, 818; 1916, **35**, 72; Ann. Rep. Soc. Chem. Ind. See E. P. 17016, 1913, F. P. 460971, 1913; abst. C. A. 1914, **8**, 2781, 1915, **9**, 355.
9. E. P. 130651, 1918; abst. J. S. C. I. 1919, **33**, 739-A; C. A. 1920, **14**, 72.
10. U. S. P. 1286255, 1286256, 1918, 1308173, 1919; E. P. 105065, 108459, 110545, 130035, 1917; F. P. 479656, 1916; Addn. 20201, 20202; Swiss P. 78274, abst. C. A. 1917, **11**, 2137, 3041; 1918, **12**, 42, 584; 1919, **13**, 2218; J. S. C. I. 1916, **35**, 1179; 1918, **37**, 18-A, 266-A; 1919, **38**, 135-A.
11. Bull. soc. encour. ind. nat. 1917, **127**, 568; **128**, 294; J. four. elec. et electrolyse, 1917, **26**, 233; abst. C. A. 1917, **11**, 2666, 1918, **12**, 566.
12. D. R. P. 250356, 253707, 253708, abst. J. S. C. I. 1912, **31**, 1053; 1913, **32**, 109; Ann. Rep. Soc. Chem. Ind. 1916, **1**, 272.
13. U. S. P. 1128780, 1159376, 1915, F. P. 467778, 1914; abst. C. A. 1915, **9**, 1064; J. S. C. I. 1914, **33**, 830; 1915, **34**, 1250.
14. Ann. 1918, **417**, 93; abst. C. A. 1919, **13**, 1827. See W. Mamchot and J. Haas, Ann. 1913, **399**, 123; abst. C. A. 1913, **7**, 3483.
15. E. P. 132558, 132559, 1918; abst. C. A. 1920, **14**, 287; J. S. C. I. 1919, **33**, 819-A, 846-A. Can Chem. J. 1919, **3**, 258; abst. C. A. 1919, **13**, 2678.
16. E. P. 10377, 1914; F. P. 471225; D. R. P. 220854, 286400, 1913; Norw. P. 26093, 26094, 1916; abst. C. A. 1915, **9**, 2796; 1916, **10**, 1254, 1578, J. S. C. I. 1914, **33**, 961; 1915, **34**, 282.

man,¹ S.-t.² G. Crume,³ S. Utheim,⁴ A. Guyot,⁵ and Soc. Anon. de Produits Chimiques (Établissements Maletta),⁶ Verein. f. Chemische Industrie,⁷ P. Mühsam,⁸ M. Moest and E. Schirm,⁹ Union Carbide Co.,¹⁰ and Darrasse Freres and L. Dupont.¹¹

Other sources of acetic acid production have been advocated, as from the waste sulfite liquor in pulp manufacture,¹² from sea weed,¹³ peat,¹⁴ and especially in the fermentation of saccharine matter.¹⁵ In the concentration of acetic acid, the methods of Aktien Ges. f. Anilin Fabrikation,¹⁶ J. Behrens,¹⁷ H. Bergstrom,¹⁸ C. Dreyfus and A. Green,¹⁹ E. Galitzenstein,²⁰ T. Goering,²¹ Harburger Chemische Werke Schon & Co.²² and E. Klein,²³ represent the most advanced practice. The purification of acetic

1. E. P. Appl. 8352, 1917, abst. J. S. C. I. 1917, **36**, 61.
2. Umschau, 1917, **21**, 187, abst. Chem. Zentr. 1919, **90**, H, 61.
3. U. S. P. 1315543, 1315546, 1919, abst. C. A. 1919, **13**, 2882, J. S. C. I. 1919, **38**, 846-A. H. Hibbert, U. S. P. 1230899, 1917, abst. C. A. 1917, **11**, 3041, J. S. C. I. 1917, **36**, 925.
4. E. P. 116279, 1918, Norw. P. 29011, Swed. P. 28501, 1918, abst. C. A. 1918, **12**, 2573, 1919, **13**, 26, J. S. C. I. 1919, **38**, 411 A.
5. U. S. P. 1343715, 1920, abst. C. A. 1920, **14**, 2344.
6. E. P. 140784, 1920, abst. C. A. 1920, **14**, 2203.
7. D. R. P. 301274, abst. J. S. C. I. 1920, **39**, 426 A. Swiss P. 62350, 1913; Chem. Ztg. 1913, **37**, 1442.
8. D. R. P. Ann. M. 42944, 1910, Chem. Ztg. 1912, **36**, 252.
9. U. S. P. 1337253, 1920, abst. J. S. C. I. 1920, **39**, 501 A. C. A. 1920, **14**, 1834.
10. Can. P. 178237.
11. E. P. 123325, 1919, abst. J. S. C. I. 1920, **39**, 499-A.
12. F. Alkier, U. S. P. 431243, 1890. M. Platsch, E. P. 19600, 1912. Power Gas Corporation, Ltd., E. P. 134265, 1918, abst. J. S. C. I. 1920, **39**, 38-A. See Norw. P. Ann. 15642, 1919, Chem. Ztg. 1920, **44**, 350.
13. Societe Darrasse Freres, E. P. 123325, 1919, abst. C. A. 1919, **13**, 1521.
14. T. Rigby and Wetcarbonizing, Ltd., E. P. 1676, 1911. See also E. P. 10834, 1903; 17610, 1911, 25146, 1912.
15. F. Coxon, Intern. Sugar J. 1918, **20**, 70, abst. C. A. 1918, **12**, 1000; J. S. C. I. 1918, **37**, 218-A. P. Keuchennus, Arch. Rubbercultuur, 1917, **1**, 413; abst. C. A. 1918, **12**, 1011.
16. D. R. P. 302673, 1915, Aust. P. 72460, 1916, abst. C. A. 1917, **11**, 1017; J. S. C. I. 1918, **37**, 370-A.
17. F. P. 325013, 1903, abst. Mon. Sci. 1904, **61**, 43.
18. U. S. P. 1261344, 1918.
19. E. P. 20445, 1898.
20. Zts. ang. Chem. 1916, **29**, 148, abst. J. S. C. I. 1916, **35**, 535, C. A. 1916, **10**, 2143.
21. D. R. P. 28064, 1893.
22. D. R. P. 292959, 1915, Dan. P. 21175, 1916, Swed. P. 42172, 1917, abst. C. A. 1916, **10**, 2024; 1917, **11**, 1519, 2138; J. S. C. I. 1916, **35**, 962.
23. U. S. P. 1291025, 1919, abst. J. S. C. I. 1919, **38**, 266-A.

acid is detailed in the publications of Bardy,¹ J. Cavarly,² Chemische Fabrik Grunau Landshoff and Meyer, A. G.,³ Holzkohlungs-Ind. Akt. Ges.,⁴ T. Olden,⁵ C. Parsons,⁶ A. Schmidt,⁷ M. Prager,⁸ W. Bousfield and T. Lowry,⁹ K. Orton, M. Edwards and H. King,¹⁰ G. v. Belotini,¹¹ J. Behrens,¹² Chemische Fabrik Griesheim Elektron,¹³ Scott and Henderson,¹⁴ and Scott.¹⁵

Absolute acetic acid at ordinary room temperatures is a colorless strongly refracting liquid of density of 1.05148 at 18°/40°; 1.04922, 20°/40°;¹⁶ 1.055, 18°/40°;¹⁷ 1.055, 15°/4°; 0.9853, 76.5°/4°;¹⁸ 1.0439, 25°/4°, 1.01561, 50°/4°;¹⁹ 1.05272, 17.5°/4°;²⁰

1. Mon Sci 1879, **21**, 900, abst. Jahr Chem 1879, **32**, 596, J. pharm. chim. 1879, **30**, 455, Chem. Centr. 1879, **50**, 824, Chem. Tech. Rep. 1879, **18**, 11, 255, Bull. Soc. Photog. Mar. 1879.

2. U. S. P. 121586, 1871.

3. D. R. P. 305429, 305430, 1915.

4. E. P. 107606, 1916, Nor. P. 27733, 1917, abst. C. A. 1917, **11**, 2137, 2061, J. S. C. I. 1917, **36**, 962.

5. U. S. P. 100553, 1870.

6. U. S. P. 87193, 96721, 1869.

7. U. S. P. 595787, 1897.

8. D. R. P. Ann. 29181, abst. Chem. Ztg. 1913, **37**, 188.

9. Proc. Chem. Soc. 1911, **27**, 187, J. C. S. 1911, 1432, Chem. Zentr. 1911, **82**, II, 852, Bull. Soc. Chim. 1912, (4), **12**, 149, abst. J. S. C. I. 1911, **30**, 891, C. A. 1911, **5**, 3568. According to the Consortium f. Elektrochem. Industrie (E. P. 460971, 1913, E. P. 17016, 1913, abst. J. S. C. I. 1914, **33**, 42, 422).

10. Proc. Chem. Soc. 1911, **27**, 120, abst. J. S. C. I. 1911, **30**, 681, C. A. 1911, **5**, 3561, Chem. Zentr. 1911, **82**, II, 528.

11. E. P. 20125, 1907, abst. J. S. C. I. 1907, **26**, 1291, see also G. Glock, E. P. 28395, 1902, abst. J. S. C. I. 1903, **22**, 291.

12. E. P. 3392, 1901, abst. J. S. C. I. 1901, **20**, 474. E. P. 28839, 1910; abst. J. S. C. I. 1911, **30**, 746.

13. Chem. Fabr. Griesheim Elektron, D. R. P. 230171, 1909, abst. J. S. C. I. 1911, **30**, 360, Zts. ang. Chem. 1911, **24**, 286; Chem. Zentr. 1911, **82**, I, 359, Chem. Tech. Rep. 1911, **35**, 79, Chem. Ind. 1911, **34**, 83, Wag. Jahr. 1911, **57**, II, 21, C. A. 1911, **5**, 2536. For the resistance of sheet steel enamels to solution by acetic acid of various strengths, R. Landrum, Trans. Amer. Ceram. Soc. 1911, **13**, 494; abst. J. S. C. I. 1911, **30**, 1386; C. N. 1911, **103**, 28; Chem. Zentr. 1911, **82**, I, 755, Chem. Eng. **12**, No. 5.

14. E. P. 6711, 1896. See also Krauschwitz Thonwaarenfabrik fur Chem. Ind. E. P. 25297, 1899, abst. J. S. C. I. 1901, **20**, 42.

15. E. P. 12952, 1897.

16. R. Bousfield and T. Lowry, J. C. S. 1911, **99**, 1439, abst. C. A. 1911, **5**, 1432; Zts. ang. Chem. 1911, **24**, 2084, Chem. Zentr. 1911, **82**, II, 852; Bull. Soc. Chim. 1912, (4), **12**, 149. Their acetic acid fused within 0.005° of 16.60°.

17. D. Tsakalotos, Bull. Soc. Chim. 1911, (4), **9**, 521; abst. C. A. 1911, **5**, 3231; J. C. S. 1911, **100**, i, 514, Chem. Zentr. 1911, **82**, II, 526.

18. K. Drucker and R. Kassel, Z. phys. Chem. 1911, **76**, 369, abst. C. A. 1911, **5**, 1859; J. C. S. 1911, **100**, ii, 373; Chem. Zentr. 1911, **82**, I, 1359; Bull. Soc. Chim. 1911, (4), **10**, 1473.

19. J. Hubbard, Z. phys. Chem. 1910, **74**, 217; abst. C. A. 1910, **4**,

1.0446, 22.9°, 4°; 1.0553, 15°, 1.0635, 15°, miscible in all proportions without turbidity with water, methyl, ethyl, propyl, butyl and amyl alcohols, ethyl ether, acetone, chloroform, ethyl and amyl acetates, and, in general, a large number of organic compounds.

The properties of acetic acid have also been studied by G. Bennett,² K. Drucker and R. Kassel,³ E. Conrady,⁴ L. Frost,⁵ H. Hibbert,⁶ W. Nernst,⁷ R. Seligman and P. Williams,⁸ N. Schoorl,⁹ and J. Thomlinson,¹⁰

Acetyl chloride formerly used in the manufacture of cellulose acetate,¹¹ is no longer employed.¹² Acetic acid solutions of cellulose acetate have been proposed for photographic purposes,¹³ as a cellulose formate solvent,¹⁴ for artificial filament formation,¹⁵ incandescent mantle impregnation,¹⁶ and the esterification of

2401, J. C. S. 1910, **98**, n. 809; Bull. Soc. Chim. 1911, (4), **10**, 841; Chem. Zentr. 1910, **81**, II, 939.

20. V. Polowzow, Zts. phys. Chem. 1911, **75**, 520; J. C. S. 1911, **100**, n. 101; Chem. Zentr. 1911, **82**, I, 609; Bull. Soc. Chim. 1911, (4), **10**, 1205.

1. F. Eisenlohr, Zts. phys. Chem. 1911, **75**, 585, abst. C. A. 1911, **5**, 1218; J. C. S. 1911, **100**, n. 81; Chem. Zentr. 1911, **82**, I, 624; Bull. Soc. Chim. 1911, (4), **10**, 1221. The following are recent density determinations compared with water at 4°-20°: 1.0502 (H. Malosse, Compt. rend. 1912, **154**, 1697, abst. Chem. Zentr. 1912, **82**, II, 600).

2. J. C. S. 1915, **107**, 351, **108**, i, 212.

3. Zts. physik. Chem. 1911, **76**, 369, abst. C. A. 1911, **5**, 1859.

4. Zts. physik. Chem. 1889, **3**, 216.

5. J. Amer. Ceram. Soc. 1918, **1**, 122, abst. C. A. 1919, **13**, 175; J. S. C. I. 1919, **38**, 107-A.

6. Met. Chem. Eng. 1918, **19**, 397, abst. C. A. 1918, **12**, 2324; J. S. C. I. 1918, **37**, 671-A.

7. Zts. Elektrochem. 1916, **22**, 37, abst. C. A. 1916, **10**, 840. C. Holland, Zts. Elektrochem. 1912, **18**, 234, abst. C. A. 1912, **6**, 3215.

8. J. S. C. I. 1906, **35**, 88, abst. C. A. 1916, **10**, 1160.

9. Pharm. Weekblad, 1917, **54**, 945, abst. C. A. 1917, **11**, 3008.

10. Chem. News, 1919, **118**, 23, abst. C. A. 1919, **13**, 957.

11. E. Colby, D. R. P. 82691, abst. Phot. Corres. 1895, **32**, 628.

12. A. Wohl, D. R. P. 151867, 1901.

13. L. Lederer, E. P. 26503, 1906, abst. J. S. C. I. 1907, **26**, 1295. F. P. 371358, 1906, abst. J. S. C. I. 1907, **26**, 344; Mon. Sci. 1908, **69**, 150. D. R. P. 191326, 1906. Belg. P. 195837, 1906.

14. J. Bernberg, E. P. 2511, 1907, abst. J. S. C. I. 1907, **26**, 634; Jour. Soc. Dyers, 1907, **23**, 215. F. P. 376262, 1907, abst. J. S. C. I. 1907, **26**, 988; Mon. Sci. 1908, (4), **68**, 87. D. R. P. 189836, 189837, 1908; abst. Zts. ang. Chem. 1908, **21**, 268; Jahr. Chem. 1905-1908, II, 983; J. C. S. 1908, **94**, i, 321; Chem. Ind. 1907, **30**, 617.

15. Chem. Fabr. v. Heyden, E. P. 3973, 1911, abst. J. S. C. I. 1911, **30**, 1143, 1156; C. A. 1912, **6**, 2172. F. P. 426436, 1911; abst. J. S. C. I. 1911, **30**, 950. Aust. Appl. A-327, 11, Jan. 12, 1911. Belg. P. 232475, 1911.

16. A. Little, U. S. P. 532468, 1895.

hydrocellulose,¹ normal cellulose, and modified celluloses.

Acetic anhydride is always used in the esterizing bath in conjunction with acetic acid. The anhydride may be manufactured by a number of commercial processes, as by the methods of T. Goldschmidt,² Societe L'Oyonnithe,³ Akt. f. Anilin Fabrikation,⁴ R. Sommer,⁵ Verein fuer Chemische Industrie,⁶ W. Cohoe,⁷

1. M. Althausse, U. S. P. 679204, 1901; abst. Mon. Sci. 1901, **57**, 284. F. P. 304723, 1900; abst. J. S. C. I. 1901, **20**, 469; Chem. Ztg. 1901, **25**, 270; Mon. Sci. 1900, **59**, 20. D. R. P. 123121, 1900; abst. J. S. C. I. 1901, **20**, 1133; Zts. ang. Chem. 1901, **14**, 905; Chem. Centr. 1901, **72**, II, 567; Mon. Sci. 1900, **59**, 9; Jahr. Chem. 1901, **54**, 892. E. P. 19039, 1900; abst. J. S. C. I. 1901, **20**, 926.

2. E. P. 25430, 25433, 1908; abst. J. S. C. I. 1910, **29**, 112; Chem. Tech. Rep. 1910, **34**, 108. F. P. 407046, 1909; Addn. Oct. 16, 1909; Dec. 29, 1910; Aust. P. 45445, 1910; 50347, 1911; abst. J. S. C. I. 1910, **29**, 112, 517, 592; 1911, **30**, 768; C. A. 1911, **5**, 1562. Belg. P. 219502, 219909, 1909. D. R. P. 222236, 1908; abst. C. A. 1910, **4**, 2719; Zts. ang. Chem. 1910, **23**, 1390; Chem. Zentr. 1910, **81**, I, 1999; Chem. Tech. Rep. 1910, **34**, 275; Chem. Ind. 1910, **33**, 407; Wag. Jahr. 1910, **56**, II, 9. Compare T. Goldschmidt, E. P. 611, 1911. F. P. 407046, 1910; abst. C. A. 1912, **6**, 1849; J. S. C. I. 1911, **30**, 768; 1912, **31**, 152. H. Dreyfus, D. R. Ann. D-27465, 1912; abst. Kunst. 1913, **3**, 420. D-27952; abst. Kunst. 1914, **4**, 220. F. P. 448342, 1912, and First Addn. Apr. 18, 1913; abst. J. S. C. I. 1913, **32**, 421, 1086. First Addn. dated Oct. 16, 1909 to F. P. 407046, 1909; abst. J. S. C. I. 1910, **29**, 592. See also F. Bayer & Co., D. R. P. 127350, 1902; abst. Jahr. Chem. 1902, **55**, 816; Chem. Centr. 1902, **73**, I, 150; Zts. ang. Chem. 1902, **15**, 67; Wag. Jahr. 1901, **47**, II, 8. H. Kessler, F. P. 315938, 1901; abst. J. S. C. I. 1902, **21**, 561; D. R. P. 132605, 1902; abst. Chem. Centr. 1902, **73**, II, 167; Zts. ang. Chem. 1902, **15**, 718; Chem. Ind. 1902, **25**, 428; Wag. Jahr. 1902, **46**, 9. Verein f. Chem. Ind. Frankfurt, D. R. P. 161882, 1902; abst. Zts. ang. Chem. 1905, **18**, 1794; Chem. Zentr. 1905, **76**, II, 420; Chem. Ind. 1905, **28**, 482; Wag. Jahr. 1905, **76**, 13. D. R. P. 163103, 1902; Addn. to D. R. P. 161882; abst. Chem. Ind. 1905, **28**, 482. Wag. Jahr. 1905, **76**, II, 13. Second Addn. dated Dec. 29, 1910 to F. P. 407046, 1909; abst. J. S. C. I. 1911, **30**, 768. E. P. 611, 1911; abst. J. S. C. I. 1911, **30**, 152; C. A. 1912, **6**, 1819. D. R. P. 241898, Addn. to D. R. P. 222236; abst. C. A. 1912, **6**, 1958, 2291; Zts. ang. Chem. 1912, **25**, 189; Chem. Zentr. 1912, **83**, I, 176; Chem. Tech. Rep. 1912, **36**, 407; Wag. Jahr. 1911, **86**, II, 27. See F. P. 315938, 1901.

3. F. P. 420346, 1910; abst. Mon. Sci. 1913, **78**, 89; J. S. C. I. 1911, **30**, 307; C. A. 1912, **6**, 1959; Caout. Gutta-Percha, 1911, **8**, 5236. Soc. L'Oyonnithe, F. P. 442738, 1911; abst. Mon. Sci. 1913, **78**, 141; J. S. C. I. 1912, **31**, 1008; C. A. 1913, **7**, 2835. For purification of acetic anhydride, see G. Ornstein, U. S. P. 1069168, 1913; abst. C. A. 1913, **7**, 3195. For manufacture of acetyl chloride, consult A. Wohl, U. S. P. 710648, 1902; abst. J. S. C. I. 1902, **21**, 1411. E. P. 14032, 1902; abst. J. S. C. I. 1903, **22**, 709.

4. E. P. 23924, 1910; abst. J. S. C. I. 1911, **30**, 48; Chem. Tech. Rep. 1911, **35**, 79. F. P. 421249, 1910; abst. J. S. C. I. 1911, **30**, 423. D. R. P. 244602, 1909; abst. C. A. 1912, **6**, 2294. D. R. P. 273101; abst. Kunst. 1914, **4**, 170; Zts. ang. Chem. 1912, **25**, 751; Chem. Zentr. 1912, **83**, I, 1063; Chem. Tech. Rep. 1912, **36**, 227; Chem. Ind. 1912, **35**, 223; Wag. Jahr. 1912, **58**, II, 39; J. S. C. I. 1914, **33**, 667. See D. R. Ann. A-17838, A-21632; abst. Chem. Ztg. 1912, **34**, 1174. See Naamlooze Vennootschap Fabrik van Chem. Produkten, F. P. 461450, 1913; abst. C. A. 1914, **8**, 2604, for the manufacture of monobasic organic carboxylic acid anhydrides.

5. D. R. P. 171146; abst. Wag. Jahr. 1906, **52**, II, 18; Chem. Centr.

W. Bäuml,¹ F. Bayer & Co.,² W. Beatty,³ G. Baiteau,⁴ Bosnische Electricitaets-Akt. Ges.,⁵ Compagnie des Pro. Chim. d'Alais et de la Camargue,⁶ Chemische Fabrik vormals Hofmann & Schoeten-sack,⁷ H. Dreyfus,⁸ T. Durrans, A. Boake, and Roberts & Co.,⁹ L. Finch,¹⁰ F. de Jahn,¹¹ J. Hewitt and C. Lumsden,¹² M. Hermann,¹³ H. Kessler,¹⁴ Meister, Lucius & Bruning,¹⁵ R. Muller,¹⁶ Naamlooze Vennootschap Fabrik van chem. Producten,¹⁷ A. v. Peski,¹⁸ C. Sage,¹⁹ Sankyo Co., Ltd.,²⁰ Société Chimique des Usines

1906, **77**, II, 18

6. D. R. P. 167304, 171787, 303018, 1912, abst. Wag. Jahr 1906, **52**, II, 17; Chem. Zentr. 1918, **89**, I, 503

7. Met. Chem. Eng. 1919, **20**, 540

1. U. S. P. 752947, 1904. For velocity of hydration of anhydrides of acids of the aliphatic series, see P. Verkade, Rec. trav. Chim. 1916, **35**, 78, 299; abst. C. A. 1916, **10**, 1634, 1917, **11**, 37

2. U. S. P. 683464, 1901, F. P. 21560, 1900, F. P. 305696, 1901, D. R. P. 127350, 1900; Aust. P. 9416, abst. Chem. Centr. 1902, **73**, I, 750

3. E. P. 18823, 1912, D. R. P. 290702, 1912, abst. C. A. 1913, **7**, 553; 1914, **8**, 553; 1917, **11**, 1519

4. F. P. 474828, 1913, 475853, 1914, abst. J. S. C. I. 1915, **34**, 1116; 1916, **35**, 72; Ann. Rep. Soc. Chem. Ind. 1916, **1**, 274

5. U. S. P. 1152098, 1915, E. P. 23190, 1914, D. R. P. 281090, 1914; Swed. P. 40355, 1916, abst. C. A. 1915, **9**, 2796, 1916, **10**, 1407, 1578, J. S. C. I. 1915, **34**, 982, 1031

6. E. P. 130650, 1918, abst. J. S. C. I. 1919, **38**, 741-A

7. D. R. P. 29669, 1884

8. U. S. P. 1283115, 1918, 1338979, 1920, E. P. 17920, 1915, 100450, 100452, 100459, 1917, 130660, 130574, 1920; F. P. 478051, 1914; Addn. 20261, 20263, 20268, 1917, abst. C. A. 1916, **10**, 2965, 1917, **11**, 1882, 3041; 1918, **12**, 1195; 1919, **13**, 133, 1920, **14**, 187, J. S. C. I. 1916, **35**, 1179, 1917, **36**, 614, 668

9. E. P. 128282, 1917, 130399, 131379, 1918, abst. C. A. 1919, **13**, 2882; 1920, **14**, 187, 285; J. S. C. I. 1919, **38**, 285-A, 739-A, 1920, **39**, 74-A. See E. P. 124542; abst. C. A. 1919, **13**, 1750. U. S. P. 1326040, 1919

10. U. S. P. 1311158, 1919, abst. C. A. 1919, **13**, 2539, J. S. C. I. 1919, **38**, 696-A

11. U. S. P. 1155227, 1916, E. P. 5939, 1910, F. P. 417710, 1910; D. R. P. 283163, 1910, Aust. P. 65007, 1914, abst. C. A. 1915, **9**, 2568; 1916, **10**, 2615; J. S. C. I. 1910, **29**, 1227, 1916, **35**, 1034

12. J. S. C. I. 1916, **35**, 210, abst. J. C. S. 1916, **110**, i, 305, Ann. Rep. Soc. Chem. Ind. 1916, **1**, 278

13. Aust. P. 43160, 1910

14. D. R. P. 132605, Aust. P. 12431, abst. Chem. Centr. 1902, **73**, 189.

15. Swiss P. 75048, 76866, 1918; abst. C. A. 1918, **12**, 1051, 2083.

16. U. S. P. 1153402, E. P. 5773, 1914; F. P. 468063, D. R. P. 287049; Swiss P. 67435; Aust. P. 70783, 1915, abst. C. A. 1915, **9**, 2292, 3118; 1916, **10**, 1407; J. S. C. I. 1914, **33**, 984, 1915, **34**, 1072; Kunst. 1915, **5**, 93, 202.

17. D. R. P. 286872, 1913, Holl. P. 2484, 1918, abst. C. A. 1916, **10**, 2127; 1919, **13**, 323.

18. U. S. P. 1136630, 1915, abst. C. A. 1915, **9**, 1534

19. Perf. Essent. Oil Record, 1917, **8**, 162; abst. C. A. 1917, **11**, 3379. Cf. L. Radcliffe and S. Medofski, J. S. C. I. 1917, **36**, 628; abst. C. A. 1917, **11**, 2649.

du Rhone,¹ F. Leach,² B. Heymann³ and General Chemical Co.⁴

Ethylidene diacetate has been used for the simultaneous production of acetic anhydride and acetaldehyde,⁵ full details of which are to be found in the writings of K. Auwers, F. Kobner and F. v. Meyenburg,⁶ F. v. Darbishire and J. Thorpe,⁷ G. Boiteau,⁸ A. Boake, Roberts & Co., and T. Durran.⁹

In the manufacture of cellulose formate, formic acid of high concentration is necessary. Formic acid may be prepared by the action of CO on an alkaline hydroxide in the presence of water,¹⁰ the sodium formate being decomposed with acid and distilled.¹¹ The formate and acid may be run into a converting chamber,¹² and either cooled¹³ or distilled under reduced pressure.¹⁴

- 20 Jap P 30650, 1917, abst C A 1917, **11**, 2390
- 1 U S P 1298358, 1306963, 1919, E P 110906, 131399, 1918, F P 486591, 1918, Swiss P 71695, abst C A 1916, **10**, 2637; 1918, **12**, 484, 1919, **13**, 1715; 1920, **14**, 72, J S C I 1918, **37**, 282-A, 1919, **38**, 454-A, 846-A, J C S 1918, **114**, i, 289
- 2 E P 137701, 1919, abst J S C I 1920, **39**, 280-A
- 3 U S P 683464, 1901
- 4 Aust P Ann 2039, 1910, abst Chem Ztg 1912, **36**, 958
- 5 Societe Chimique des Usines du Rhone, U S P 1304989, 1306964, 1919; E P 112765, 112766, 1917, Swiss P 78106, 78107, 1918, abst C A 1918, **12**, 1050; J S C I 1918, **37**, 606-A, 1919, **38**, 233-A, 554-A D R P 322746, 1917, abst Chem Ztg 1920, **44**, 361 Chem Fabrik Griesheim Elektron, E P 14246, 1913, D R P 281337, 1915, abst Chem Zentr 1915, **86**, II, 235 Bosnische Elektrizitats Akt-Ges U S P 1152098, 1915, E P 23190, 1914, D R P 284996, abst Chem Zentr 1915, **86**, II, 204
- 6 Ber 1891, **24**, 2888, abst J C S 1892, **62**, 41 K Auwers and A Imhauser, Ber 1891, **24**, 2233, abst J C S 1891, **60**, 1191
- 7 J C S 1905, **87**, 1716
- 8 F P 475853, 1914, abst J S C I 1916, **35**, 72
- 9 E P Appl 18116, 1919, abst J S C I 1919, **38**, 560-A
- 10 R Koepp and Co, F P 342168, 1904, abst J S C I 1904, **23**, 911, Mon Sci 1906, (4), **65**, 6 D R P 209417, 212641, 1904, 288266, 1911, Aust P 41813, 44374, 1910, 63533, 1914, abst C A 1916, **10**, 2502 For method of preparing formates, see O Dubosc, A Luttringer and H Denis, F P 421227, 1909, E P 29165, 1910, abst J S C I 1911, **30**, 542, 804
- 11 M Hamel, F P 341764, 1904, abst J S C I 1904, **23**, 911; Mon Sci 1906, (4), **65**, 6 E P 7534, 1904, abst J S C I 1905, **24**, 289, U S P 806060, 1905, abst J S C I 1906, **25**, 39, Mon Sci 1906, (4), **65**, 117, Belg P 178039, 1904, Aust P 32492, 1908
- 12 H Schroder, D R P 234580, 1910, abst J S C I 1911, **30**, 803, Chem Zentr. 1911, **82**, I, 1767; Zts ang Chem 1911, **24**, 1152; Chem Tech. Rep. 1911, **35**, 314; Wag. Jahr. 1911, **57**, II, 19, Chem Ind. 1911, **34**, 321; C. A. 1911, **5**, 2922 D. R. P. 245168, 1909, abst. J. S. C. I. 1912, **31**, 557; Zts. ang. Chem. 1912, **25**, 990, Chem Tech Rep 1912, **36**, 295, Chem Ind 1912, **35**, 249, C. A. 1912, **6**, 2494, Chem. Zentr. 1912, **83**, I, 1266
- 13 H. Howard, U. S. P. 960927, 1910; abst. J. S. C. I. 1910, **29**, 815, Mon. Sci. 1911, (5), **75**, 74; Chem Tech. Rep. 1910, **34**, 403; C. A. 1911, **5**, 770 U. S. P. 970825, 975866, 1910, abst. Mon. Sci. 1911, (5), **75**, 98, Chem.

Other methods have been brought forward by Societe Anonyme des Usines des Moulins,¹ Farbwerke vorm. Meister, Lucius & Brüning,² Chemische Fabrik Grünau, Landshoff und Meyer Akt. Ges.,³ A. Hempel,⁴ Chemische Fabrik Griesheim Elektron,⁵ D. Strauss,⁶ Societe Anonyme des Etablissements Eycken et

Tech. Rep. 1911, **35**, 86, J. S. C. I. 1910, **29**, 815, 1453, C. A. 1910, **4**, 3286, 1911, **5**, 770. M. Neumann, U. S. P. 975151, 1910, abst. J. S. C. I. 1910, **29**, 1453; C. A. 1911, **5**, 770. W. Walker, U. S. P. 970145, 1910, abst. C. A. 1910, **4**, 3286. F. Bayer & Co., F. P. 417815, 1909, abst. C. A. 1912, **6**, 1958.

14. Soc. Chem. Ind. Basle, E. P. 8438, 1910, abst. J. S. C. I. 1910, **29**, 1036, C. A. 1911, **5**, 2153, Chem. Tech. Rep. 1910, **34**, 482, D. R. P. 239075, 1910, abst. C. A. 1912, **6**, 2290, Zts. ang. Chem. 1911, **24**, 2132, Chem. Zentr. 1911, II, 1285, Wag. Jahr. 1911, **57**, II, 20. F. P. 425321, 1911, abst. Mon. Sci. 1913, **78**, 119.

1. F. P. 382339, 1907, abst. J. S. C. I. 1908, **27**, 246, C. A. 1909, **3**, 2350; Mon. Sci. 1909, (4), **71**, 102, Chem. Tech. Rep. 1908, **32**, 178, Belg. P. 202536, 1907.

2. Farbwerke, vorm. Meister, Lucius und Brüning, E. P. 20893, 1909, abst. J. S. C. I. 1910, **29**, 1133, C. A. 1911, **5**, 2415. D. R. P. 232707, 1908, abst. C. A. 1912, **6**, 1820, Chem. Tech. Rep. 1911, **35**, 211, Chem. Ind. 1911, **34**, 225. F. P. 417815, 1909, abst. J. S. C. I. 1911, **30**, 27, Mon. Sci. 1913, **78**, 85, Chem. Tech. Rep. 1910, **34**, 642. E. P. 8012, 1908, D. R. P. 212844, 1907, F. P. 389065, 1908, Aust. P. 48337, 18338, abst. J. S. C. I. 1908, **27**, 769, 958. See also Nitritfabrik Copemick, D. R. P. 169730, 1903, 182691, 1904, abst. C. A. 1907, **1**, 2061, Chem. Zentr. 1906, **77**, I, 1581, 1907, I, 1169, Zts. ang. Chem. 1906, **19**, 1780, 1908, **21**, 216, Wag. Jahr. 1906, **52**, 11.

3. F. P. 367316, 1906, abst. J. S. C. I. 1906, **25**, 1173, Mon. Sci. 1908, (4), **69**, 73, E. P. 14438, 1906, abst. J. S. C. I. 1906, **25**, 1173, C. A. 1907, **1**, 940, U. S. P. 857046, 1907, abst. J. S. C. I. 1907, **26**, 839, C. A. 1907, **1**, 2504, D. R. P. 193509, 1905, abst. J. C. S. 1908, **94**, i, 598, Chem. Zentr. 1908, **79**, I, 998, Zts. ang. Chem. 1908, **21**, 1000, Jahr. Chem. 1905-1908, II, 343, Chem. Zts. 1908, **7**, 562, Wag. Jahr. 1908, **54**, II, 11, Chem. Ind. 1908, **31**, 102. U. S. P. 1174663, 1916, E. P. 16215, 1915, D. R. P. 305429, 1914, Swiss P. 72378, 1916, Aust. P. 35148, 1908, abst. C. A. 1916, **10**, 2387, 1917, **11**, 1519, J. S. C. I. 1916, **35**, 468, 635. Chem. Fabr. Grünau, Landshoff, Meyer, E. Franke and W. Kirschner, D. R. P. 243225, 1910, abst. J. S. C. I. 1912, **31**, 334, Chem. Zentr. 1912, **83**, 618, Zts. ang. Chem. 1912, **25**, 508, Chem. Tech. Rep. 1912, **36**, 159, Chem. Ind. 1912, **35**, 152, C. A. 1912, **6**, 2292. In the process of the Soc. pour l'Industrie Chim. Bale (F. P. 423321, 1910, abst. J. S. C. I. 1911, **30**, 1012).

4. E. P. 3428, 1908, abst. J. S. C. I. 1909, **28**, 259, C. A. 1909, **3**, 2207, Chem. Tech. Rep. 1909, **33**, 334, F. P. 389039, 1908, U. S. P. 1017261, 1912, abst. J. S. C. I. 1908, **27**, 958, 1912, **31**, 282.

5. D. R. P. 230171, 1909, abst. J. S. C. I. 1911, **30**, 360, C. A. 1911, **5**, 2536, Zts. ang. Chem. 1911, **24**, 286, Chem. Zentr. 1911, **82**, 359, Chem. Tech. Rep. 1911, **35**, 79, Wag. Jahr. 1911, **57**, II, 21, Chem. Ind. 1911, **34**, 82. For the use of sulfonic acids, see also their D. R. P. 235752, 1909, abst. C. A. 1911, **5**, 3488, 1912, **6**, 960, Zts. ang. Chem. 1911, **24**, 1549, Chem. Zentr. 1911, **82**, 240, Chem. Tech. Rep. 1911, **35**, 348, Chem. Ind. 1911, **34**, 428.

6. D. R. P. 209418, 1907, abst. J. S. C. I. 1909, **28**, 674, C. A. 1909, **3**, 2211; Zts. ang. Chem. 1909, **22**, 1082, Chem. Zentr. 1909, **80**, 1915, Chem. Zts. 1909, **8**, 1507; Chem. Tech. Rep. 1909, **33**, 209, Wag. Jahr. 1909, **55**, II,

- Leroy,¹ J. Weise,² Badische Aniline und Soda Fabrik,³ H. Sulzer,⁴ H. Sulzer-Rieter,⁵ C. Kingzett and R. Woodcock,⁶ P. Sabatier and A. Mailhe,⁷ M. von Unruh,⁸ M. Vaygouny,⁹ W. Walker,¹⁰ A. Wiens,¹¹ Societe Anonyme Le Camphre,¹² M. Berthelot,¹³ A. Brauer,¹⁴ G. Bredig,¹⁵ and with S. Carter,¹⁶ W. de Coninck,¹⁷ Elektrochemische Werke,¹⁸ C. Ellis and K. McElroy,¹⁹ F. Fritz,²⁰ Gesellschaft für Chem. Ind. 1909, **32**, 311. For the method of O. and P. Piequet, see Belg. P. 185701, 1905.
1. F. P. 393526, 1908; abst. J. S. C. I. 1909, **28**, 160; Mon. Sci. 1911, (4), **71**, 135; Chem. Tech. Rep. 1909, **33**, 53.
 2. U. S. P. 1043985, 1912; abst. J. S. C. I. 1912, **31**, 1178.
 3. F. P. 372714, 1906; abst. J. S. C. I. 1907, **26**, 527; Mon. Sci. 1908, (4), **69**, 82. E. P. 22038, 1906; abst. J. S. G. I. 1907, **26**, 967.
 4. Zts. ang. Chem. 1912, **25**, 1268; abst. J. S. C. I. 1912, **31**, 682; Chem. Zentr. 1912, **83**, I, 814; J. C. S. 1912, **102**, i, 610; Chem. Tech. Rep. 1912, **36**, 405; Ital. P. 378/126/122772; Abst. Chem. Ztg. 1913, **37**, 32.
 5. D. R. P. 243797, 1911; abst. J. S. C. I. 1912, **31**, 385; Zts. ang. Chem. 1912, **25**, 605; Chem. Zentr. 1912, **83**, II, 761; Chem. Tech. Rep. 1912, **36**, 146; Chem. Ind. 1912, **35**, 190; Wag. Jahr. 1912, **58**, II, 29. E. P. 784, 1912; abst. J. S. C. I. 1912, **31**, 817. F. P. 438965, 1912; abst. J. S. C. I. 1912, **31**, 588; Mon. Sci. 1913, **78**, 136.
 6. J. S. C. I. 1912, **31**, 265; Chem. Zentr. 1912, **83**, I, 1715; Zts. ang. Chem. 1912, **25**, 1657; J. C. S. 1912, **102**, i, 367; Chem. News, 1912, **105**, 26; Chem. Tech. Rep. 1912, **36**, 360; C. A. 1912, **6**, 1275.
 7. For the catalytic esterification of formic acid, see Compt. rend. 1911, **152**, 1044; abst. J. S. C. I. 1911, **30**, 648; Bull. Soc. Chim. 1912, (4), **11**, 84; J. C. S. 1911, **100**, i, 416; C. A. 1911, **5**, 2630; Chem. Zentr. 1911, **82**, I, 1810. For exhaustive article on the manufacture of formic acid, see A. Duboscq, Bull. Soc. Chim. Rouen, 1907, **38**, 128-89, 328-63; 1913, **41**, 83-6; abst. C. A. 1911, **5**, 473; 1913, **7**, 504. O. Duboscq, A. Luttringer and H. Denis, U. S. P. 1019230, 1912. For the properties of formic acid, see T. Walther, Faerb. Ztg. 1911, **22**, 61, 83; abst. J. S. C. I. 1911, **30**, 416.
 8. U. S. P. 891753, 1907; abst. J. S. C. I. 1908, **27**, 918; Chem. Tech. Rep. 1908, **32**, 413. For the A. Hempel method of producing formates, see F. P. 389039, 1908; U. S. P. 1017261, 1912; abst. J. S. C. I. 1908, **27**, 958; 1912, **31**, 282. See also J. R. Bucher, U. S. P. 1083589, 1914; abst. C. A. 1914, **7**, 991.
 9. U. S. P. 1185028, 1916; abst. C. A. 1916, **10**, 1817; J. S. C. I. 1916, **35**, 736.
 10. U. S. P. 1048609, 1912; abst. J. S. C. I. 1913, **32**, 141; Chem. Ztg. 1913, **37**, 215.
 11. U. S. P. 993331, 1911; F. P. 362417, 1906; abst. J. S. C. I. 1906, **25**, 714; 1911, **30**, 748.
 12. Belg. P. 231217, 1910; Aust. P. 55442, 1912.
 13. Bull. Soc. Chim. 1874, **22**, 440; Jahr. Chem. 1874, **27**, 519; Chem. Tech. Rep. 1874, **13**, II, 211.
 14. U. S. P. 1174663, 1916; abst. C. A. 1916, **10**, 1406; J. S. C. I. 1916, **35**, 468; Chem. Ind. 1916, **39**, 468.
 15. U. S. P. 1204933, 1916; 1235426, 1917; abst. C. A. 1917, **11**, 187, 2580; J. S. C. I. 1916, **35**, 1261; 1917, **36**, 1008.
 16. E. P. 801, 9762, 1915; abst. C. A. 1916, **10**, 1911; 1917, **11**, 86; J. S. C. I. 1915, **34**, 1143; 1207.
 17. Rev. gen. chim. 1916, **19**, 68; abst. C. A. 1916, **10**, 2577.
 18. D. R. P. 179515, 1905; F. P. 362417, 1906; Belg. P. 188838, 1905.
 19. U. S. P. 867575, 875055, 1907; abst. J. S. C. I. 1907, **26**, 1163; Chem.

schaft f. Chemische Industrie,¹ M. Goldschmidt,² L. Grognot,³ H. Haakh,⁴ P. Haas,⁵ C. Harries,⁶ E. Higgins,⁷ K. Hofmann and H. Schibsted,⁸ Holzverkohlungs Ind. Akt. Gs.,⁹ G. Ita,¹⁰ A. Jones,¹¹ S. Katz and F. Ovitz,¹² S. Keimatsu and B. Ikeda,¹³ A. Lackman,¹⁴ F. Metzger,¹⁵ Nitritfabrik Ges.,¹⁶ J. Raschen, C. Higgins and The United Alkali Co.,¹⁷ Chemische Fabrik Grünau, Landshoff and Mayer A. G.,¹⁸ R. Koepp & Co.,¹⁹ P. Thomas,²⁰ Society for Chemical Industry Basle,²¹ J. Weise, F. Reiche and A. Barth,²² and Chemische Werke vorm. H. Byk.²³

Manufacture of Acetated Cellulose. The proper commercial manufacture of the cellulose acetates is a science and also an art. A science in that certain chemical and physical principles in well defined and analytically determinable limits are involved; an art in that the personal equation in manipulative ability is of paramount importance. Personal contact and practical experience

Ind. 1907, **30**, 1163.

20. Zts. ang. Chem. 1915, **28**, I, 272, abst. C. A. 1915, **9**, 2088.
1. Aust. P. 50863, 1912; abst. Chem. Ztg. 1913, **37**, 44. See F. P. 382339, 1907.
2. D. R. P. 86419, 1884. F. Feldkamp, U. S. P. 802980, 1905.
3. Belg. P. 193724, 1906.
4. D. R. P. 281044, 1913; abst. C. A. 1915, **9**, 1833.
5. Zts. Elektrochem. 1916, **22**, 443, abst. J. S. C. I. 1917, **36**, 81.
6. Ber. 1919, **52**, 65; abst. J. S. C. I. 1919, **38**, 318-A.
7. E. P. 23377, 1912.
8. Ber. 1918, **51**, 1389; abst. J. S. C. I. 1918, **37**, 782-A.
9. D. R. P. 307550, 1914, E. P. 107606, Swed. P. 43430, 1918; abst. C. A. 1917, **11**, 2961; 1918, **12**, 1469.
10. E. P. 28375, 1906.
11. Ann. Rep. Soc. Chem. Ind. 1910, **1**, 227.
12. U. S. P. 1212359, 1917, abst. J. S. C. I. 1917, **36**, 385.
13. J. Pharm. Soc. Japan, 1915, No. 399, 499, abst. C. A. 1915, **9**, 2232.
14. U. S. P. 1274169, 1918; abst. J. S. C. I. 1918, **37**, 622-A. G. Lüttgen, D. R. P. Anm. I-35650, 40701, 40786.
15. U. S. P. 1313312, 1919, abst. J. S. C. I. 1919, **38**, 765-A.
16. Belg. P. 191501, 1906.
17. E. P. 13953, 1907, abst. J. Soc. Dyers Color. 1908, **24**, 142; J. S. C. I. 1908, **27**, 420. In this connection see the following: U. S. P. 802980, 820159, 820373, 820374, 875055, 993331; E. P. 90008, 1906; 4471, 13953, 1908; F. P. 362417, 382001, 342169.
18. D. R. Anm. C-21350, 1911; abst. Chem. Ztg. 1912, **36**, 751.
19. Aust. P. Anm. 8584, 1912; abst. Chem. Ztg. 1913, **37**, 712.
20. Ann. Inst. Pasteur, 1920, **14**, 162; abst. J. S. C. I. 1920, **39**, 481-A.
21. Aust. P. Anm. 2461, 1910; abst. Chem. Ztg. 1912, **36**, 1005.
22. U. S. P. 820374, 1906. See Anon., Chem. Age, 1920, **2**, 453; C. A. 1920, **14**, 1834.
23. D. R. P. Anm. 56325, 1909; abst. Chem. Ztg. 1912, **36**, 556. For determination of formic and acetic acids in presence of each other, see R. Laufmann, Chem. Ztg. 1915, **39**, 575.

with the innumerable nuances of gradation from cellulose to the desired finished product is substantially a necessity for commercial uniformity. So often the patent specification of cellulose acetate manufacture is voluminous in description, but fragmentary in imparting useful details.

The first patent for the manufacture of cellulose acetate¹ was granted to C. Cross and E. Bevan in 1894. L. Lederer² superficially acetylated cellulose for waterproofing textiles in 1910. In the esterification of modified cellulose (hydrocellulose, oxycellulose and regenerated cellulose) the process of C. Weber and C. Cross,³ A. Rychengruen and T. Becker,⁴ B. Boesch,⁵ Badische Anilin & Soda Fabrik,⁶ H. Peters and H. Cullum,⁷

1 U. S. P. 530826, 1894. E. P. 9676, 1894; abst. J. S. C. I. 1895, **14**, 496, 987, Amateur Photog., London, 1899, **30**, 146, Brit. Jour. Photog. 1899, **46**, 771, Chem. Centr. 1896, **67**, 405. D. R. P. 85329, 1894; abst. Chem. Centr. 1896, **67**, I, 1119, II, 567, Mon. Sci. 1900, (4), **55**, 134; Wag. Jahr. 1896, **42**, 684, Ber. 1896, **29**, 312, Jahr. Chem. 1896, **49**, 1030. D. R. P. 86368, 1895, being addition to D. R. P. 85329, 1894; abst. Chem. Centr. 1896, **67**, II, 567. F. P. 243546, 1894. Belg. P. 113156, 1894. See also H. Rauch, Chem. Tech. Woch. 1919, 81, abst. Kunst. 1919, **9**, 177.

2 U. S. P. 954310, 1910, abst. J. S. C. I. 1910, **29**, 557, Mon. Sci. 1910, (4), **73**, 135, Chem. Tech. Rep. 1910, **34**, 209. E. P. 11164, 1902, abst. J. S. C. I. 1903, **22**, 646. F. P. 320885, 1902, abst. J. S. C. I. 1903, **22**, 142, 160. F. P. 441864, 1912, abst. J. S. C. I. 1912, **31**, 916, Mon. Sci. 1913, **78**, 141. E. P. 7687, 1912, J. S. C. I. 1913, **32**, 483, C. A. 1913, **7**, 3025. F. P. 455117, 1913; Kunst. 1913, **3**, 439; abst. Mon. Sci. 1914, **80**, 11, J. S. C. I. 1913, **32**, 865. E. P. 3849, 1913, abst. J. S. C. I. 1913, **32**, 940. See also Verein. f. Chem. Industrie in Mainz, E. P. 6266, 1914.

3 U. S. P. 632605, 1899. E. P. 22029, 1898, abst. J. S. C. I. 1899, **18**, 756. Can. P. 63101, 1899. D. R. P. 112817, abst. Chem. Centr. 1900, **71**, II, 510, Zts. ang. Chem. 1900, **13**, 773, Jahr. Chem. 1900, **53**, 843, Wag. Jahr. 1900, **46**, II, 450. Russ. P. 3264, 1900. Belg. P. 137577, 1898. Dan. P. 2558, 1899. Port. P. 2930, 1899.

4 U. S. P. 734123, 1903, abst. J. S. C. I. 1903, **22**, 961, Mon. Sci. 1903, (4), **60**, 173. D. R. P. 153350, 1901, abst. Zts. ang. Chem. 1904, **17**, 1697, Chem. Centr. 1904, **75**, 625, Jahr. Chem. 1904, **57**, 1168, J. C. S. 1904, **86**, i, 863, Chem. Ind. 1904, **27**, 538. E. P. 21628, 1901, abst. J. S. C. I. 1902, **21**, 870. F. P. 317007, 1901; abst. J. S. C. I. 1902, **21**, 870, Mon. Sci. 1903, **60**, 54. Ital. P. 62042, 1901. See also their D. R. Ann. E-17505, being addition to D. R. P. 256922; abst. Zts. ang. Chem. 1913, **26**, 700. D. R. Ann. F-28233 of 1909. F-32828 of 1911. F-28111 of 1909. E-14316, 1909. E-14993, 1909. E-15581, 1909, being addition to E-14998. U. S. P. 790565, 1905; abst. J. S. C. I. 1905, **24**, 686. D. R. P. 159524, 1901, abst. Chem. Centr. 1905, **76**, II, 527; Zts. ang. Chem. 1905, **18**, 1636; Jahr. Chem. 1905, **76**, II, 984; J. C. S. 1906, **90**, i, 6; Chem. Ind. 1905, **28**, 535. Aust. P. 31391.

5 U. S. P. 708456, 1902; abst. J. S. C. I. 1902, **21**, 1243. U. S. P. 708457, 1902; abst. J. S. C. I. 1902, **21**, 1243, Mon. Sci. 1903, (4), **60**, 165.

6 U. S. P. 862098, 1906; abst. J. S. C. I. 1906, **25**, 232; Mon. Sci. 1906, (4), **64**, 120. E. P. 24083, 1904, abst. J. S. C. I. 1905, **24**, 1081. F. P. 347906, 1904; abst. J. S. C. I. 1905, **24**, 454, Mon. Sci. 1906, (4), **64**, 15; Chem. Ztg. 1905, **29**, 493. D. R. P. 184145, 1904; abst. Chem. Zentr. 1907,

L. Grote,¹ L. Landsberg,² G. Miles,³ A. Woh,⁴ F. Bayer & Co.,⁵
H. Danzer,⁶ Chemische Fabrik von Heyden,⁷ Knoll & Co.,⁸

78, (5), **11**, 365; Mon Sci. 1909, (4), **70**, 77, Jahr Chem. 1905-1908, II, 983; Zts. ang. Chem. 1908, **21**, 268, Chem Ind 1907, **30**, 238, Wag. Jahr 1907, **53**, II, 401. D. R. P. 184201, 1904; abst. Zts. ang. Chem. 1908, **21**, 268; Chem. Zentr. 1907, **78**, 365, Mon Sci. 1909, (4), **70**, 77, Jahr Chem. 1905-1908, II, 984; Chem Ind 1907, **30**, 257, Wag. Jahr 1907, **53**, II, 402. Aust. P. 35015, Belg. P. 182216, 1905. Swed. P. 20249, 1905. Russ. P. 11492, 1907. See also their E. P. 14042, 1911. E. P. 22237, 1911; abst. J. S. C. I. 1912, **31**, 279, C. A. 1913, **7**, 1287, Kunst. 1913, **3**, 175. F. P. 435507, 1911, abst. J. S. C. I. 1912, **31**, 329. Belg. P. 239564, 1911, 218907, 1912. Ital. P. 73 230, 120751 of 1911. D. R. P. Ann. A-21107 of Sept. 24, 1911, abst. Kunst. 1913, **3**, 60.

7. U. S. P. 1008489, 1911, abst. J. S. C. I. 1911, **30**, 1447, Mon Sci. 1912, **77**, 163. U. S. P. 1008557, 1911, abst. J. S. C. I. 1911, **30**, 1447. E. P. 16000, 1911; abst. J. S. C. I. 1912, **31**, 637, C. A. 1913, **7**, 252, Kunst. 1913, **3**, 175. E. P. 822, 1912, J. S. C. I. 1912, **31**, 637. E. P. 2859, 1912. See also their F. P. 432747, 1911, abst. Mon Sci.

1. E. P. 23728, 1912, abst. C. A. 1914, **8**, 1346. F. P. 470274, 1912.

2. E. P. 4886, 1902, abst. J. S. C. I. 1903, **22**, 315. F. P. 316500, 1901, abst. J. S. C. I. 1902, **21**, 719, abst. Mon Sci. 1903, (4), **59**, 53. Aust. P. 17456, 1902. D. R. Ann. L-15737.

3. U. S. P. 733729, 1903, Can. P. 90848, 1905. U. S. P. 838350, 1906, Reissue thereon, 12637, 1907, abst. Mon Sci. 1907, (4), **66**, 116, 159, J. S. C. I. 1906, **25**, 195, 1907, **26**, 165. E. P. 13330, 1905, F. P. 358079, 1905, Hung. P. 35866, 1905; Belg. P. 187308, 1905, Aust. P. 41461, 1909, Can. P. 103045; Ital. P. No. 97, vol. 215, 1905, D. R. P. Ann. M-28289, 1905, issued as D. R. P. 252706, 1905 to Farbenfabriken vorm. F. Bayer & Co., abst. Zts. ang. Chem. 1912, **25**, 2621, Chem Ind 1912, **35**, 770, Kunst. 1913, **3**, 35, C. A. 1913, **7**, 550. See also F. Bayer & Co., D. R. Ann. E-20063, 1905, being addition to D. R. P. 252706, abst. J. S. C. I. 1903, **22**, 961, 1906, **25**, 865.

4. E. P. 20527, 1912, abst. J. S. C. I. 1913, **32**, 823. F. P. 448072, 1912, abst. J. S. C. I. 1913, **32**, 420, Kunst. 1913, **3**, 195, Mon Sci. 1914, **80**, 3.

5. E. P. 24067, 1906, abst. J. S. C. I. 1907, **26**, 1213, F. P. 371447, 1906, abst. J. S. C. I. 1907, **26**, 340, Mon Sci. 1908, (4), **68**, 79, Chem. Tech. Rep. 1907, **31**, 149. D. R. P. 322586, 1912. Consult. Jacquet, E. P. 20882, 1913, D. R. Ann. H-57941, 1912, R. Hoernberg.

6. F. P. 428554, 1910, abst. J. S. C. I. 1911, **30**, 1155, Chem. Tech. Rep. 1911, **35**, 576, C. A. 1912, **6**, 2169, Mon Sci. 1913, **78**, 125.

7. F. P. 438649, 1912, abst. J. S. C. I. 1912, **31**, 534, Kunst. 1912, **2**, 439. D. R. Ann. W-30500, 1911, being addition to D. R. Ann. W-30036, on the preparation of hydrocellulose esters of organic acids, refused. See F. Bayer & Co., D. R. P. 252661, 1912, Addn. to D. R. P. 245575; abst. Zts. ang. Chem. 1912, **25**, 1034, 2381, Chem. Ztg. 1912, **34**, 1174, Chem. Tech. Rep. 1912, **36**, 248, 610, Chem Ind 1912, **35**, 775, Chem. Zentr. 1912, **83**, 1709. Also Act. Ges. f. Anilinfabr. E. P. 1156, 1913, D. R. Ann. A-23352, Jan. 15, 1913.

8. F. P. 453835, 1913, J. S. C. I. 1913, **32**, 785. For the method of manufacturing cellulose ester solutions by Plinatus, see E. P. 16940, 1913. According to F. P. 452374, 1912, and Addn. P. 17104 of 1913 thereto, amines as aniline, toluidine and the xyldines, or benzene and ethyl alcohol and toluene and methyl alcohol are efficient for transforming acetone insoluble into acetone soluble cellulose acetates. E. P. 8090, 1912, J. S. C. I. 1913, **32**, 823. F. P. 442512, 1912; Chem. Tech. Rep. 1912, **36**, 693; C. A. 1913, **7**, 1288, J. S. C. I. 1912, **31**, 917; Belg. P. 224950, 1912; Kunst. 1912, **2**, 300.

Verein für Chem. Ind. in Mainz,¹ Chemische Fabrik auf Actien, vorm. E. Schering and A. Loose,² W. Parkin and A. Williams,³ V. Pauthonier,⁴ H. Dreyfus,⁵ H. Mork,⁶ Internationale Cellulose-ester Ges.,⁷ and F. Ulzer,⁸ indicate the methods which have primarily depended upon the utilization of a modified cellulose as the starting point in the preparation of acetylated esters.

In the acetation with sulfuric acid containing catalysts, are to be included lead chamber crystals, sulfuricnicoleic acid,⁹ am-

D. R. Ann. K-47775, April 28, 1911. D. R. Ann. 120, K-50333, 1913; Kunst. 1913, **3**, 279. Belg. P. 253353, 1913; abst. Kunst. 1913, **3**, 355. E. P. 16905, 1913. See also Knoch & Co., D. R. Ann. K-48490, of July 14, 1911; D. R. P. 255704, 1911; abst. Kunst. 1913, **3**, 40; Chem. Zentr. 1913, **84**, 482. D. R. Ann. K-52025, of July 17, 1912; K-52789, of Oct. 9, 1912; abst. Kunst. 1913, **3**, 200. E. P. 2491, 1913; F. P. 453835, 1913; abst. C. A. 1914, **8**, 2482; J. S. C. I. 1913, **32**, 785; 1914, **33**, 308. D. R. P. 273706, 1911; abst. Kunst. 1914, **4**, 179. E. P. 4353, 1913; abst. C. A. 1914, **8**, 2804; J. S. C. I. 1914, **33**, 349. D. R. P. 274260, 1912; abst. Kunst. 1914, **4**, 234. D. R. P. 297504, 303530, 305348, 305884, 305151; abst. Kunst. 1919, **9**, 186.

1. E. P. 3849, 1913; abst. C. A. 1914, **8**, 573, 2620. F. P. 455117, 1913; abst. C. A. 1914, **8**, 573; J. S. C. I. 1913, **32**, 865; E. P. 3849, 19008, 1913.

2. E. P. 27227, 1912; abst. C. A. 1914, **8**, 1668. F. P. 452374, 1912; J. S. C. I. 1913, **32**, 652, 784. F. P. 450890, 1912. First addition dated Jan. 16, 1913, to F. P. 452374, 1912; abst. J. S. C. I. 1913, **32**, 784. See also D. R. Ann. 120, C-21994, of 1912. D. R. P. Ann. C-21994, C-22781, C-23703, 1912.

3. E. P. 26657, 1909; abst. J. S. C. I. 1910, **29**, 1152. F. P. 421010, 1910; abst. J. S. C. I. 1911, **30**, 416.

4. F. P. 466009, 1913; abst. J. S. C. I. 1914, **33**, 589; Kunst. 1914, **4**, 235.

5. A series of patents for solubility variation by hydration has been granted to H. Dreyfus, E. P. 20975, 20976, 1911; 20852, 21376, 1912; abst. C. A. 1913, **7**, 890; 1914, **8**, 1010. Swiss P. 63586, 1911; abst. C. A. 1914, **8**, 252. U. S. P. 1286172, 1918; 1325931, 1919; E. P. 114304, 1918; abst. J. S. C. I. 1918, **37**, 687-A; 1920, **39**, 153-A. F. P. 432264, 1914; third addn.; E. P. 128215, 1919; abst. J. S. C. I. 1916, **35**, 40; 1920, **39**, 445-A. Can. P. 155274, 1914.

6. U. S. P. 1061771, 1913; abst. C. A. 1912, **7**, 2707; J. S. C. I. 1913, **32**, 597. F. P. 416752, 1910; abst. J. S. C. I. 1910, **29**, 1371. E. P. 20672, 1910; abst. J. S. C. I. 1911, **30**, 354; C. A. 1911, **5**, 2947. See also his U. S. Applications, 637857, 637858, 1911. If a chloroform-soluble, non-hydrated, acetone-insoluble cellulose acetate be taken, dissolved in absolute acetone, and a little dry sodium carbonate added, the cellulose acetate in 12-24 hours will pass into solution, thus showing that the sodium carbonate hydrolyzes cellulose acetate from the form insoluble in acetone to that modification completely soluble. In U. S. P. 1074092, 1913; abst. J. S. C. I. 1913, **32**, 975; Mon. Sci. 1914, **80**, 11; Kunst. 1914, **4**, 157; C. A. 1913, **7**, 3839; H. Mork applies the hydrolysis as described in U. S. P. 1061771, 1913, to sheets, films and filaments. See also Safety Celluloid Co. F. P. 458263, 1913; abst. C. A. 1914, **8**, 2251.

7. D. R. P. 260984, 1912; abst. Kunst. 1912, **2**, 300; **3**, 273; J. S. C. I. 1913, **32**, 748; C. A. 1913, **7**, 3228.

8. Mitth. Tech. Gewerbemus. 1905, 241; abst. Wag. Jahr. 1905, **51**, II, 192.

9. V. Pauthonier, E. P. 27102, 1909; abst. J. S. C. I. 1911, **30**, 19;

monium bisulfate,¹ sulfur trioxide,² sulfinic acid,³ phenol sulfonic acid,⁴ sulfuric acid and sodium acetate,⁵ nitric acid,⁶ ammonium nitrate,⁷ dimethyl sulfate,⁸ benzene sulfinic acid,⁹ ethyl sulfuric

Chem. Tech. Rep. 1911, **35**, 59. F. P. 409465, 1909; abst. J. S. C. I. 1910, **29**, 751.

1. Societe L'Oyonnithe, F. P. 427265, 1911; abst. J. S. C. I. 1911, **30**, 1051; Chem. Tech. Rep. 1911, **35**, 481, Mon. Sci. 1913, **78**, 123. Hung Appl. O-674, 1912. Aust. P. 29b, A-1787, 1912; Kunst. 1912, **2**, 460. See also A. Wohl, D. R. P. 139669, 1903; abst. Jahr. Chem. 1903, **56**, 1014; Chem. Ind. 1903, **26**, 167; Wag. Jahr. 1903, **49**, II, 418; Zts. ang. Chem. 1903, **16**, 285; Chem. Centr. 1903, **74**, I, 744. D. R. P. 243581, 1908; abst. J. S. C. I. 1912, **31**, 381; Chem. Abst. 1912, **6**, 2316; Chem. Tech. Rep. 1912, **36**, 190; Zts. ang. Chem. 1912, **25**, 654; Chem. Ind. 1912, **35**, 190; Chem. Centr. 1912, **83**, I, 695. E. P. 20527, 1912; abst. C. A. 1911, **8**, 1010. See D. R. Ann. W-30500; being addition to W-30436, W-38008, of Aug. 31, 1911, abst. Kunst. 1913, **3**, 180.

2. Societe anonyme L'Oyonnaxienne, F. P. 432751, 1911, abst. J. S. C. I. 1912, **31**, 123. See also P. Ekstroem, Swed. P. 33540, 1911; abst. C. A. 1913, **7**, 289. P. Engelskirchen, D. R. P. 255441, 1911; abst. C. A. 1913, **7**, 1587.

3. C. Schwalbe, Zts. ang. Chem. 1910, **23**, 433; abst. Jahr. Chem. 1910, **63**, I, 648; Chem. Zentr. 1910, **81**, I, 1964; Bull. Soc. Chim. 1910, (4), **8**, 694; J. C. S. 1910, **38**, i, 224.

4. H. Mork, A. Little and W. Walker, U. S. P. 709922, 1902, abst. J. S. C. I. 1902, **21**, 1345. E. P. 20660, 1902; abst. J. S. C. I. 1903, **22**, 1011. F. P. 324862, 1902; abst. J. S. C. I. 1903, **22**, 646, Mon. Sci. 1904, (4), **60**, 43. Knoll & Co. (E. P. 8990, 1912; abst. C. A. 1913, **7**, 3113; J. S. C. I. 1913, **32**, 823) take cellulose acetates insoluble in chloroform and render them soluble by treatment with such catalysts as sulfuric acid, neutral salts, or sulfates such as methylamine bisulfate, or organic sulfonic or sulfinic acids.

5. Knoll & Co. E. P. 8727, 1908; abst. J. S. C. I. 1908, **27**, 996. Addn. 9194, dated April 16, 1908, to F. P. 376578, 1907; abst. J. S. C. I. 1908, **27**, 996. D. R. P. 201910, 1907; abst. Chem. Zts. 1909, **8**, 1052; Zts. ang. Chem. 1908, **21**, 2333; Chem. Zentr. 1908, **79**, I, 1349, II, 1310, Mon. Sci. 1912, **76**, 57. D. R. P. 201910, being addition to D. R. P. 196730, 1906; abst. Mon. Sci. 1912, **77**, 57. Belg. P. 199492, 1907.

6. A. and H. Knoll and M. Daege (Knoll & Co.) E. P. 8389, 1907, abst. J. S. C. I. 1907, **26**, 1213. F. P. 376578, 1907, abst. J. S. C. I. 1907, **26**, 988; Mon. Sci. 1908, (4), **68**, 88. D. R. P. 196730, 1906; abst. C. A. 1908, **2**, 2301; Mon. Sci. 1911, (3), **74**, 92; Chem. Zts. 1908, **7**, 806; Zts. ang. Chem. 1908, **21**, 1194; Jahr. Chem. 1905-1908, II, 898; Chem. Ind. 1908, **31**, 422; Wag. Jahr. 1908, **54**, II, 365. Aust. P. 36126, 37138.

7. L. Lederer (E. P. 26502, 1906; abst. J. S. C. I. 1907, **26**, 634. F. P. 371357, 1906; abst. J. S. C. I. 1907, **26**, 340; Mon. Sci. 1908, (4), **68**, 69. Belg. P. 195839, 1906).

8. A. Corti and Fabrique de Produits Chimiques Flora Societe Anonyme, U. S. P. 826229, 1906; abst. J. S. C. I. 1906, **25**, 825; Mon. Sci. 1907, (4), **66**, 35; E. P. 9998, 1905; abst. J. S. C. I. 1905, **24**, 855. F. P. 345764, 1904; abst. J. S. C. I. 1905, **24**, 40; Mat. Color. 1905, **8**, 53; Mon. Sci. 1906, (4), **64**, 12. D. R. P. Ann. C-12963, 1903. Belg. P. 183877, 1905. Ital. Appl. P. dated April 17, 1905.

9. Knoll & Co. E. P. 2020, 1907; abst. J. S. C. I. 1907, **27**, 353. F. P. 369123, 1906; abst. J. S. C. I. 1907, **26**, 91; Mon. Sci. 1908, (4), **68**, 28. D. R. P. 180666, 1905; abst. Zts. ang. Chem. 1907, **20**, 1786; Mon. Sci. 1909, (4), **70**, 77; Jahr. Chem. 1905-1908, II, 982; Wag. Jahr. 1907, **53**, II, 404. D. R. P. 180667, 1905, being addition to D. R. P. 180666, 1905; abst. Chem. Ind. 1907, **30**, 110; Zts. ang. Chem. 1907, **20**, 1786; Mon. Sci. 1909, (4), **70**,

acid,¹ aniline bisulfate,² alkylamine sulfuric salts,³ anhydrous copper salts,⁴ nitrosulfuric acid,⁵ ferrous sulfate,⁶ pyridine sulfate,⁷ 77; *Jahr. Chem.* 1905-1908, II, 982. Knoll & Co. (D. R. P. 272121, 1911; abst. *J. S. C. I.* 1914, **33**, 640; *Kunst.* 1914, **4**, 192), prefer as an ester, sulfuric acid, acid sodium ethyl-sulfate, a chloroform soluble and acetone insoluble ester resulting when one part of cellulose is acted upon at 100° with four parts each acetic anhydride and glacial acetic acid and 0.04 part acid sodium ethyl sulfate.

1. C. Dreyfus, F. P. 430606, 1911; abst. *J. S. C. I.* 1911, **30**, 1375.
2. F. Bayer & Co. U. S. P. 987692, 1911; abst. *J. S. C. I.* 1911, **30**, 485; *Chem. Tech. Rep.* 1911, **35**, 250. E. P. 14271, 1910; abst. *J. S. C. I.* 1911, **30**, 485. F. P. 417274, 1910; abst. *J. S. C. I.* 1911, **30**, 485. See also A. Eichengruen and F. Bayer & Co., *Aust. Ann.* 27258, 1910, 237, 1910, 5012, 1910, 5806, 1910; *Aust. P.* 52289, 1911; 50331 1912. *Hung. Ann.* E-1568, Jan 13, 1910. *Swiss P.* 52273, 1910; 53888, 1910, being addition to 52273; 57952, 1910. *Belg. P.* 226582, 1910, 227385, 1910, D. R. *Ann.* F-32823. D. R. P. 233786, 1911. D. R. *Ann.* E-1558, Dec. 27, 1909, being addition to F-14998; abst. *Kunst.* 1912, **2**, 340, 359. In *Addn.* 18345, to F. P. 417274, 1910, abst. *Kunst.* 1914, **4**, 235; *J. S. C. I.* 1914, **33**, 478, acid sulfates of aromatic amines may be replaced by neutral sulfates of amines. Example 50 parts of cellulose are acetylated by a mixture of 250 parts of acetic anhydride, 200 of glacial acetic acid and 20 of methylamine sulfate or *o*-toluidine sulfate, at 30°-60°. The product obtained is soluble in a mixture of ethyl acetate and ethyl alcohol 4 : 1, in a mixture of chloroform and alcohol, and of nitrobenzene and alcohol. Aniline sulfate is also claimed as efficient.
3. A. Loose and Chem. Fabr. auf Aktien (vorm. E. Schering), U. S. P. 1069445, 1913; abst. *J. S. C. I.* 1913, **32**, 865; *Mon. Sci.* 1914, **80**, 39, *Chem. Abst.* 1913, **7**, 3227. E. P. 27227, 1912, abst. *J. S. C. I.* 1913, **32**, 696; *Kunst.* 1913, **3**, 395; C. A. 1913, **7**, 4069. E. P. 27228, 1912, abst. *J. S. C. I.* 1913, **32**, 530; C. A. 1914, **8**, 1668. E. P. 2178, 1913, abst. *Kunst.* 1914, **4**, 15; *J. S. C. I.* 1913, **32**, 975. F. P. 450890, 1912, abst. *J. S. C. I.* 1913, **32**, 531, *Kunst.* 1913, **3**, 195; C. A. 1913, **7**, 3227; *Mon. Sci.* 1914, **80**, 6. F. P. 452374, 1912, abst. *Kunst.* 1913, **3**, 274; *Mon. Sci.* 1914, **80**, 8; *J. S. C. I.* 1913, **32**, 652; C. A. 1913, **7**, 3663. *Belg. P.* 251010, abst. *Kunst.* 1913, **3**, 235. *Belg. P.* 251011; abst. *Kunst.* 1913, **3**, 235. *Belg. P.* 252882; abst. *Kunst.* 1913, **3**, 275. D. R. *Ann.* 120, C-21388, dated Dec. 18, 1911; abst. *Kunst.* 1913, **3**, 20. See their D. R. *Ann.* C-21994 and C-23703, *Addn.* 17104 to F. P. 452374, abst. *Kunst.* 1913, **3**, 416; C. A. 1913, **7**, 4069; *J. S. C. I.* 1913, **32**, 784. Also their E. P. 2178, 1913, abst. C. A. 1914, **8**, 2620.
4. F. Paschke and the Safety Celluloid Co. E. P. 15868, 1912, abst. *J. S. C. I.* 1913, **32**, 192; C. A. 1913, **7**, 3025. U. S. P. 1082167, 1913; abst. *J. S. C. I.* 1914, **33**, 72; C. A. 1914, **8**, 821. F. P. 458263, 1913; abst. *J. S. C. I.* 1913, **32**, 1064. *Hung. P.* Ann. S-6854. *Badische Anilin und Soda Fabrik.* E. P. 14042, 1914.
5. Akt. Ges. für Anilin Fabrikation, E. P. 10706, 1912; abst. C. A. 1913, **7**, 3414. Compare E. P. 1156, 1914, *Addn.* to E. P. 10706, 1912, abst. *J. S. C. I.* 1914, **33**, 688. See also D. R. P. 295889, 299036, 301449; abst. *Kunst.* 1919, **9**, 186.
6. Knoll & Co. D. R. P. 203178, 1906; abst. *Jahr. Chem.* 1905-1908, II, 984; *Chem. Zentr.* 1908, **79**, II, 1549; *Chem. Zts.* 1909, **8**, 1053; *Mon. Sci.* 1912, **77**, 96; *Zts. ang. Chem.* 1908, **21**, 2426; *Wag. Jahr.* 1908, **54**, II, 365. D. R. P. 206950, 1907, being addition to D. R. P. 203178, 1906; abst. *Chem. Zts.* 1909, **8**, 1183; *Zts. ang. Chem.* 1909, **22**, 656; *Mon. Sci.* 1912, **77**, 96; *Chem. Ind.* 1909, **32**, 153; *Wag. Jahr.* 1909, **55**, II, 397; *Jahr. Chem.* 1909, 386. E. P. 2026A, 1907; abst. *J. S. C. I.* 1908, **27**, 353.
7. C. Claessen, D. R. P. 222450, 1908; abst. *J. S. C. I.* 1910, **29**, 811; *Zts. ang. Chem.* 1910, **23**, 1389; *Wag. Jahr.* 1910, **56**, II, 434; *Chem. Zentr.* 1910, **81**, II, 48; *Chem. Zts.* 1910, **9**, 1902; C. A. 1910, **4**, 2875.

and benzene sulfinic acid,¹ are among the catalysts proposed.

It has also been proposed to nullify the destructive tendency of sulfuric acid by the use of trichloroacetic acid,² monochloroacetic acid,³ sulfacetic acid,⁴ chlorides of phosphorus⁵ or sulfur,⁶ or nitric acid.⁷ In all of the above processes the cellulose passes into solution in the esterizing mixture, and is precipitated therefrom by means of water at the close of the process.

Cellulose acetates may also be prepared in the fibrous or

1. E. Knoevenagel, F. P. 369123, 1906, U. S. P. 1090074, 1914, abst. C. A. 1914, **8**, 1667, J. S. C. I. 1907, **26**, 91, 1914, **33**, 349.
2. Knoll & Co., D. R. P. 203642, 1906, abst. Zts. ang. Chem. 1908, **21**, 2334, 2426, Chem. Zts. 1909, **8**, 1218, Wag. Jahr. 1908, **54**, II, 367, Chem. Zentr. 1908, **79**, II, 1705, Jahr. Chem. 1905-1906, II, 983, Chem. Ind. 1908, **31**, 711; Mon. Sci. 1912, **77**, 96, Belg. P. 190492, 1907. For manufacture of dichloroacetic acid, see K. Brand, D. R. P. 216661, 1911, abst. J. S. C. I. 1912, **31**, 796; Chem. Zentr. 1912, **91**, 1742, Zts. ang. Chem. 1912, **25**, 1657, Wag. Jahr. 1912, **58**, II, 40.
3. Actien-Gesellschaft fur Ammonfabrikation, F. P. 14255, 1906, abst. J. S. C. I. 1907, **26**, 220, C. A. 1907, **1**, 1341, F. P. 368738, 1906, abst. J. S. C. I. 1907, **26**, 30, D. R. P. 198482, 1905, abst. Mon. Sci. 1911 (5), **74**, 64, Zts. ang. Chem. 1908, **21**, 1760, Chem. Zentr. 1908, **79**, II, 118, Jahr. Chem. 1905-1908, II, 982; Chem. Ind. 1908, **31**, 378, Wag. Jahr. 1900, **46**, II, 362.
4. Societe Anonyme D'Explosifs et de produits Chimiques, F. P. 385179, 1907, Mon. Sci. 1909, (4), **70**, 105; Bull. Soc. Chim. 1909, (4), **6**, 557; J. S. C. I. 1908, **27**, 589, C. A. 1909, **3**, 2383, F. P. 385180, 1907, Mon. Sci. 1909, (4), **70**, 106, Bull. Soc. Chim. 1909, (4), **6**, 557, J. S. C. I. 1908, **27**, 589; C. A. 1909, **3**, 2383.
5. M. Balston and J. Briggs, F. P. 10243, 1903, abst. J. S. C. I. 1904, **23**, 557.
6. Chemische Fabrik von Heyden, F. P. 24382, 1910, abst. J. S. C. I. 1911, **30**, 616; C. A. 1911, **5**, 3157, F. P. 423197, 1910, abst. J. S. C. I. 1911, **30**, 615; Chem. Tech. Rep. 1911, **35**, 307, Swiss P. 54497, 1910, Belg. P. 229995, 1910, U. S. P. 1051165, 1913, abst. J. S. C. I. 1913, **32**, 192, Kunst. 1913, **3**, 275; Mon. Sci. 1913, **79**, 107, D. R. P. 269193, 1909, abst. Kunst. 1914, **4**, 20, 97; C. A. 1914, **8**, 2251, Aust. P. Ann. A-8062, 1910, abst. Kunst. 1912, **2**, 460. In a later process (D. R. P. 273029, 1910, Addn. to D. R. P. 269193; abst. Kunst. 1914, **4**, 234) improvements due to the use of pyro-sulfuryl chloride are described by Chem. Fabrik von Heyden.
7. Knoll & Co. U. S. P. 891218, 1908, abst. J. S. C. I. 1908, **27**, 765; Mon. Sci. 1909, (4), **70**, 116, F. P. 2026-B, 1907, abst. J. S. C. I. 1908, **27**, 353, F. P. 373994, 1907, abst. J. S. C. I. 1907, **26**, 776, Mon. Sci. 1908, (4), **68**, 83; Chem. Tech. Rep. 1907, **31**, 302, D. R. P. 201233, 1906, Chem. Zts. 1908, **7**, 993; Zts. ang. Chem. 1908, **21**, 2233, Chem. Zentr. 1908, **79**, II, 994, Chem. Ind. 1908, **31**, 587, Wag. Jahr. 1908, **54**, II, 366, Jahr. Chem. 1905-1908, 962, D. R. P. 203178, 1906, abst. Chem. Zts. 1909, **8**, 1053, Zts. ang. Chem. 1908, **21**, 2426, Chem. Zentr. 1908, **79**, II, 1549; Jahr. Chem. 1905-1908, II, 984; Chem. Ind. 1908, **31**, 741. See also D. R. Ann. K-50334, of Feb. 1, 1912, being addition to D. R. P. 203178, 1906; abst. Kunst. 1914, **4**, 160, Knoll & Co. D. R. Ann. K-50980, K-50605; both being addition to D. R. P. Ann. K-50333; abst. Kunst. 1914, **4**, 40, 179. In their D. R. P. 273029, 1910, Addn. to D. R. P. 269193; abst. C. A. 1914, **8**, 2251, 2806, for the manufacture of fatty acid esters of cellulose or their closely related conversion products by means of fatty acid anhydrides in the presence of sulfur chlorides, in order to prevent great rise in temperature during the acetylation, the cotton is previously dried.

granular form by introducing in the esterification bath a cellulose acetate non-solvent as benzene. Examples of acetate prepared in this manner are to be found in the processes of L. Lederer,¹ H. Mork,² Societe Debaugé et Cie,³ H. Dreyfus,⁴ Knoll & Co.,⁵ International Celluloseester-Gesellschaft.⁶ The Soc. chimiques des Usines du Rhone acetate either in the presence of 5% sulfuric acid,⁷ with acetic anhydride in vapor form,⁸ nitric acid,⁹ trioxymethylene,¹⁰ or methylene sulfate.¹¹

Other methods of cellulose acetylation have been described

1. U. S. P. 902003, 1908, 999236, 1911, abst. J. S. C. I. 1911, **30**, 1050; E. P. 26501, 1906, 3103, 1907; abst. J. S. C. I. 1907, **26**, 889; F. P. 374370, 1907; abst. J. S. C. I. 1907, **26**, 776; Mon. Sci. 1908, (4), **68**, 84; Chem. Zts. 1907, **6**, 139. In this connection see D. R. P. 185151; F. P. 371356; Aust. P. 31203. See also Lederer, Belg. P. 244470, 1912, abst. Kunst. 1912, **2**, 399; E. P. 7687, 1912, abst. Kunst. 1913, **3**, 274.

2. U. S. P. 854374, 1907, abst. J. S. C. I. 1907, **26**, 713; Mon. Sci. 1907, (4), **66**, 159; C. A. 1907, **1**, 2316; G. Esselen and H. Mork, U. S. P. 1275885, 1918; abst. C. A. 1918, **12**, 2248; J. S. C. I. 1918, **37**, 651-A.

3. F. P. 450886, 1913, abst. Kunst. 1913, **3**, 195; C. A. 1913, **7**, 3297.

4. F. P. 432046, 1911, First Addn. 14558, dated July 7, 1911, Second Addn. 14559, dated July 15, 1911, Third Addn. 15933, dated Jan. 4, 1912, Fourth Addn. 15894, dated April 1, 1912, Fifth Addn. 16316, dated April 1, 1912, Sixth Addn. dated Aug. 5, 1912, Seventh Addn. 16494, dated Sept. 16, 1912; F. P. 448342, 1912, Addn. 17674; F. P. 432047, 1912, Addn. 15719, abst. J. S. C. I. 1912, **31**, 21, 225, 1119, 1913, **32**, 283, 420; Chem. Ztg. 1912, **34**, 1174; E. P. 20677, 20978, 20979, 1911, 20852, 21376, 22645, 1912; Belg. P. 241250, 246250, 246251, 1912, abst. Jour. Soc. Dyers, 1913, **29**, 91; J. S. C. I. 1913, **32**, 133, 1063; J. S. C. I. 1913, **32**, 891; Kunst. 1913, **3**, 95, 194, 434, 435; Belg. P. 241250, 246250, 246251, 1912; Port. 8348, 1912; Aust. P. 12-o, Mar. 16, 1910, Mar. 9, 1911. See also E. P. 19330, 1905, 26657, 1909; E. P. Addn. 15933 to F. P. 432046, abst. Kunst. 1913, **3**, 435; D. R. Ann. D-20439, 1913, abst. Kunst. 1913, **3**, 439.

5. D. R. P. 273706, 1911, abst. J. S. C. I. 1914, **33**, 746.

6. D. R. P. 242289, 1910, abst. C. A. 1912, **6**, 2170; Wag. Jahr. 1912, **58**, 11, 17; Kunst. 1913, **3**, 35; Chem. Zts. 1912, **11**, 2798; Chem. Tech. Rep. 1912, **36**, 47; Zts. ang. Chem. 1912, **25**, 286; Chem. Ind. 1912, **35**, 87; Chem. Zentr. 1912, **83**, 1, 298.

7. Societe Chimique des Usines du Rhone, F. P. 473399, 1914; E. P. 136996, 1914; U. S. P. 1258913, 1914; Swiss P. 59412, 68996, 1914; D. R. P. Ann. dated June 25, 1913, abst. C. A. 1915, **9**, 3358, 1918, **12**, 1420; J. S. C. I. 1915, **34**, 488, 606; 1918, **37**, 265-A; Swiss P. 78108.

8. Societe Chimique des Usines du Rhone, U. S. P. 1030311, 1912; J. S. C. I. 1912, **31**, 680; Mon. Sci. 1913, **78**, 11; C. A. 1912, **6**, 2528; Chem. Ztg. 1912, 485; Can. P. 139046, 1912, abst. C. A. 1912, **6**, 1526; E. P. 25893, 1912; abst. J. S. C. I. 1912, **31**, 279; Kunst. 1913, **3**, 174; C. A. 1913, **7**, 609; F. P. 437240, 1911, abst. J. S. C. I. 1912, **31**, 429; Mon. Sci. 1913, **78**, 134; D. R. P. 258879, 1910, abst. C. A. 1913, **7**, 3227; Kunst. 1913, **3**, 140; Swiss P. 50412, 1911. See also their E. P. 136996, 1914, for the manufacture of acid esters of cellulose.

9. Societe Chimique des Usines du Rhone, F. P. Addn. 20072, 1915; to F. P. 473399, 1914; E. P. 7763, 8046, 1915; U. S. P. Appl. Ser. No. 31707, 1915; Swiss P. 71991, 1915; D. R. P. Ann. dated June 12, 1914, abst. C. A. 1916, **10**, 2299, 3150; J. S. C. I. 1916, **35**, 39, 1106.

10. Societe Chimique des Usines du Rhone, F. P. 477620, 1914; E. P.

and patented by Aktien Gesellschaft fur Anilin Fabrikation,¹

- Badische Anilin u. Soda Fabrik,² Societe pour l'Ind. Chim. à Bâle,³
- J. Blanksma,⁴ L. Clement and C. Riviere,⁵ C. Cross and J. Briggs,⁶
- H. Dreyfus,⁷ A. Eichengrün,⁸ Chemische Fabrik von Heyden,⁹
- Knoll & Co.,¹⁰ L. Landsberg,¹¹ I. Lederer,¹² P. Leemans,¹³ L. Lilienfeld,¹⁴ W. Lindsay,¹⁵ A. Plotsky,¹⁶ A. Puschel,¹⁷ J. Radcliffe,¹⁸ Chem-

7773, 1915, U. S. P. 1216462, 1915, Swiss P. 71605, abst. C. A. 1916, **10**, 1301, 3160, J. S. C. I. 1911, **30**, 357, 1916, **35**, 302, 1917, **36**, 383. E. P. 128911, 1919.

11. Societe Chimique des Usines du Rhone, F. P. 478436, 1914, E. P. 10822, 1915, U. S. P. 1191439, 1914, Swiss P. 77663, 1915, D. R. P. Ann. June 12, 1915; abst. C. A. 1916, **10**, 2298, 2299, 1917, **11**, 209, 1918, **12**, 2139, J. S. C. I. 1915, **34**, 1086, 1916, **35**, 1009, 1918, **37**, 2139.

1. D. R. P. 295889, 1916, 299036, 1917, Swiss P. 61424, 61710, 1912, Ital. P. 120751, 1911, 127915, 1912, Hung. Appl. A. 1829, abst. Chem. Zentr. 1917, **88**, I, 350, 1918, **89**, I, 396, Chem. Ztg. 1913, **37**, 11. F. P. 635507, abst. Kunst. 1919, **9**, 186.

2. Norw. P. 15082.

3. F. P. 476383, 1914, E. P. 21016, 1914, abst. J. S. C. I. 1916, **35**, 39.

4. Chem. Weekblad, 1909, **6**, 717, abst. J. C. S. 1909, **96**, i, 779.

5. Bull. Soc. Encour. Ind. Nat. 1913, 53.

6. U. S. P. 920828, 1909, F. P. 383064, 1908.

7. U. S. P. 1181857, 1916, Re. 14338, 1917, 1278885, 1280974, 1280975, 1286172, 1918, E. P. 21628, 1901, 20877, 20955, 20956, 20957, 20958, 20959, 1911, 20852, 1912, 6463, 14101, 1915, 100009, 101555, E. P. Appl. 420, 1916, 7500, 1917, 11872, 11873, 1918, 12469, 12915, 15033, 15191, 21474, 21602, 21773, 1919, F. P. 432046, Addn. 16316, 16391, 175160, 178023, 1914, Can. P. 191800, 191801, 191802, 1919, Swiss P. 63586, 67113, Belg. P. 241250, 1911, Aust. P. Appl. Mar. 16, 1910, March 9, 1911, see E. P. 19303, 1905, 26657, 1909, 24382, 1910, 10852, 21376, 22645, 1912, abst. C. A. 1913, **7**, 891, 1914, **8**, 1010, 1916, **10**, 1269, 1433, 1790, 2637, 1917, **11**, 209, 705, 2010, 1918, **12**, 2687, 1919, **13**, 1927, J. S. C. I. 1912, **31**, 24, 225, 329, 1916, **36**, 40, 60, 629, 686, 1152, 1917, **36**, 7, 51, 1001, 1918, **37**, 449 A, 729 A, 1919, **38**, 358 A, 394 A, 448 A, 483 A, 750 A, Chem. Ztg. 1913, **37**, 163, Kunst. 1915, **5**, 95.

8. D. R. P. 287745, 295764, 296205, 1910, abst. Chem. Ztg. Rep. 1917, **41**, 64, Chem. Zentr. 1915, **86**, II, 864, 1917, **88**, I, 463. See also D. R. P. 254385, Kunst. 1919, **9**, 186.

9. Swiss P. 54497, 1910, Aust. P. Ann. 8062, 1910.

10. D. R. P. 293261, 1916, 297504, 303530, 305348, 305884, 306131, 1918, abst. Chem. Zentr. 1916, **87**, II, 361, 1917, **88**, I, 1038, 1918, **89**, I, 499, 977, II, 236, 325, Aust. P. Ann. A-541, 1913, Aust. P. 33452, 1908, Ital. P. 38547, 124854, Belg. P. 197484, 1907, 207839, 1908, abst. Chem. Ztg. 1913, **37**, 272.

11. Belg. P. 160378, 1901.

12. Belg. P. 163251, 1902, 195840, 1906, Aust. P. 67812, Norw. P. 16291, 16292, abst. Kunst. 1914, **4**, 94.

13. Belg. P. 182051, 1905.

14. Swiss P. 66512, abst. Kunst. 1915, **5**, 70.

15. U. S. P. 1236578, 1236579, 1917, 1265216, 1918, 1338661, 1920, abst. C. A. 1917, **11**, 2963, 1918, **12**, 1699, J. S. C. I. 1917, **36**, 1092, 1918, **37**, 461 A, 1920, **39**, 445 A, L'Ind. Chim. 1918, **5**, 93. Cf. U. S. P. 1226330, 1226340. See F. Zimmer, Farben Ztg. 1918, **23**, 331.

16. U. S. P. 1296847, 1919, E. P. 75, 1915, abst. J. S. C. I. 1916, **35**,

ische Fabrik auf Actien (vorm. E. Schering) and A. Loose,¹ Snowden & Co., Ltd.,² W. Stevenson,³ G. Finck,⁴ B. Borzykowski,⁵ R. Müller,⁶ J. Zdanowitch,⁷ and F. Ruppert.⁸

Changing the solubility in the process to partial hydration or "ripening," first patented by G. Miles, has been extended by Aktien Gesellschaft für anilin Fabrikation,⁹ E. Wagner,¹⁰ F. Collischonn,¹¹ C. Cross and C. Dreyfus,¹² Naamlooze Vennootschap Fabrik van Chemische Producten,¹³ H. Dreyfus,¹⁴ B. Gaisenband and C. Piestrak¹⁵ and E. Knoevenagel.¹⁶

The Deutsche Celluloid Fabrik¹⁷ have described a peculiar compound obtained by treating mercerized cellulose with chloroacetic or chloropropionic acids in the presence of an alkaline hydroxide, a clear paste being formed, soluble in water and precipitated by alcohol. The sodium salt dissolves readily in hot or cold water forming viscous solutions. E. Berl¹⁸ dissolves cellulose in 60%-77% sulfuric acid, and coagulates by methyl

39; 1919, **38**, 358-A.

17. Aust. P. 65040, 1914; abst. Kunst. 1914, **4**, 274.

18. E. P. 131357, 1918; abst. J. S. C. I. 1919, **38**, 750-A; C. A. 1920, **14**, 123.

1. D. R. P. Anm. C-21388; abst. Chem. Ztg. 1913, **37**, 92.

2. Ital. P. 378/246/122890; abst. Chem. Ztg. 1913, **37**, 32.

3. E. P. 130029, 1917; abst. C. A. 1920, **14**, 123.

4. D. R. Anm. F-32472, 1911; Chem. Ztg. 1912, **36**, 901.

5. Aust. P. 60039. Swiss P. 60510, Chem. Ztg. 1913, **37**, 834, 953.

6. D. R. Anm. M-63043, 1918; M-67869, 1919; Chem. Ztg. 1920, **44**, 342, 367.

7. E. P. 139232, 1918; abst. C. A. 1920, **14**, 2084.

8. U. S. P. 1263119, 1918; Swiss P. 62359, 66046, 66047; abst. C. A. 1918, **12**, 1508; J. S. C. I. 1918, **37**, 367-A; Kunst. 1915, **5**, 72, 95.

9. D. R. P. 295889, 301449, 1917; abst. Chem. Zentr. 1917, **88**, I, 350; II, 714.

10. D. R. P. 299181, 1914; abst. J. S. C. I. 1920, **39**, 400-A.

11. U. S. P. 1201260, 1916; abst. C. A. 1916, **10**, 3159; J. S. C. I. 1916, **35**, 1356.

12. E. P. 125153, 1916; abst. J. S. C. I. 1919, **38**, 427-A.

13. Holl. P. 3146, 1919; abst. C. A. 1920, **39**, 1439. See D. R. P. 163316, 1901.

14. U. S. P. 1217722, 1242783, 1917; 1286172, 1280974, 1280975, 1918; E. P. 20978, 1911; 21376, 1912; abst. C. A. 1917, **11**, 45; 1919, **13**, 73; J. S. C. I. 1917, **36**, 451; 1918, **37**, 765-A. Can. P. 183250, 1918.

15. F. P. 483316, 1917.

16. U. S. P. 1241995, 1917; F. P. 453835, 1913; D. R. P. 297504, 305348, 1918; abst. J. S. C. I. 1913, **32**, 785; 1917, **36**, 1174; C. A. 1918, **12**, 223; Chem. Zentr. 1918, **89**, I, 499, 977.

17. E. P. 138116, 1920.

18. F. P. 454753; 1913; abst. J. S. C. I. 1913, **32**, 865; Mon. Sci. 1914, **77**, 10. D. R. P. 259248, 1912; abst. J. S. C. I. 1913, **32**, 653.

or ethyl alcohols in the manufacture of artificial filaments.

Cellulose Formate.¹ Transformation of cellulose into formic esters has been found much more difficult than acetation, partly due to the more energetic reactivity of formic acid. These formic esters may be prepared from normal cellulose, cellulose hydrate,² and waste from artificial silk manufacture.³ The catalysts which have been proposed include sulfuric acid,⁴ zinc chloride,⁵

1. For résumé of formylcellulose, containing 334 bibliographic references in 65 notes, see E. Worden and L. Rutstein, *Kunst* 1912, **2**, 325 8, abst. C. A. 1912, **6**, 3329; *Chem. Tech. Rep.* 1912, **36**, 562. See also Caout et Gutta-p. 1913, **10**, 6897; *Kunst* 1913, **3**, 352. E. Worden, *Chem. Eng.* 1913, **17**, 26; abst. C. A. 1913, **7**, 2304. C. Nøyer, *Kunst* 1914, **4**, 207.
2. U. S. P. 953677, 955082, 1910; abst. J. S. C. I. 1910, **29**, 557; *Mon. Sci.* 1910, (4), **73**, 131. E. P. 17036, 1909; abst. J. S. C. I. 1910, **29**, 1005. F. P. 405293, 1909; abst. J. S. C. I. 1910, **29**, 417; *Mon. Sci.* 1910, (4), **73**, 171; *Chem. Tech. Rep.* 1910, **34**, 75. D. R. P. 219162, 219163, 1907; abst. *Jahr. Chem.* 1910, **63**, I, 426; *Zts. ang. Chem.* 1910, **23**, 768; *Chem. Ind. Jahr.* 1910, **33**, 186; *Wag. Jahr.* 1910, **56**, II, 433; *Mon. Sci.* 1914, **81**, 80; *Chem. Zts.* 1910, **9**, 1986, 1988. Aust. P. 45765, 1909. Hung. Ann. N. 952, July 21, 1909. It. P. 103978, 1909. Belg. P. 198984, 198985, 217837, 1907.
3. U. S. P. 1046729, 1912, 1061977, 1913; abst. J. S. C. I. 1913, **32**, 653; C. A. 1913, **7**, 700, 2471; *Mon. Sci.* 1914, **80**, 23. E. P. 15700, 1910; 6241, 1911; abst. J. S. C. I. 1910, **29**, 1199, 1912, **31**, 279; C. A. 1911, **5**, 2723, 1912, **6**, 2529; *Chem. Tech. Rep.* 1912, **36**, 532. F. P. 420856, 1910; abst. J. S. C. I. 1911, **30**, 279; *Mon. Sci.* 1913, **78**, 113. First Add. to F. P. 420856, dated Mar. 13, 1911; abst. J. S. C. I. 1911, **30**, 1050. D. R. P. 233589, 1909; abst. *Zts. ang. Chem.* 1911, **24**, 860; *Chem. Zts.* 1912, **11**, 2733; C. A. 1912, **6**, 2169, 2170, 2315; *Chem. Zentr.* 1911, **82**, I, 1333; *Chem. Tech. Rep.* 1912, **36**, 675; *Wag. Jahr.* 1912, **58**, II, 18. D. R. P. 254083, 1910; being Add. to D. R. P. 233589, 1909; abst. *Chem. Zentr.* 1913, **84**, I, 83; *Chem. Tech. Rep.* 1912, **36**, 693; *Kunst* 1913, **3**, 52, 260; C. A. 1913, **7**, 1288. Belg. P. 233792, 234433, 1911, 229046, 1910. Aust. P. 49177, 54819, 57421, 60447; abst. *Kunst.* 1912, **2**, 456, 1913, **3**, 218, 395. Swiss P. 53585, 1910. Hung. Ann. G. 3306, Mar. 13, 1911. Can. P. 133197, 1911. The formic acid employed is the ordinary formic acid of commerce, of about 96% strength by weight. The cellulose hydrates will dissolve in this formic acid at ordinary room temperatures, but a temperature of 40°-50° is preferable. At higher temperatures the solution is more rapidly formed, but is more thinly flowing.
4. E. P. 2511, 1907; abst. J. S. C. I. 1907, **26**, 634; *Jour. Soc. Dyers*, 1907, **23**, 215. F. P. 376262, 1907; abst. J. S. C. I. 1907, **26**, 688; *Mon. Sci.* 1908, (4), **68**, 87. D. R. P. 189836, 189837, 1908; abst. *Zts. ang. Chem.* 1908, **21**, 268; *Jahr. Chem.* 1905-1908, II, 983; J. C. S. 1908, **94**, i, 321; *Chem. Ind.* 1907, **30**, 617; *Wag. Jahr.* 1907, **53**, II, 400. D. R. P. 189836 specifies formylation in the presence of sulfuric acid, while D. R. P. 189837 claims the use of gaseous HCl, 2-4 parts being required for 20-30 parts of cellulose.
5. U. S. P. 953677, 955082, 1910; abst. J. S. C. I. 1910, **29**, 557; *Mon. Sci.* 1910, (4), **73**, 131. E. P. 17036, 1909; abst. J. S. C. I. 1910, **29**, 1005. F. P. 405293, 1909; abst. J. S. C. I. 1910, **29**, 417; *Mon. Sci.* 1910, (4), **73**, 171; *Chem. Tech. Rep.* 1910, **34**, 75. D. R. P. 219162, 219163, 1907; abst. *Jahr. Chem.* 1910, **63**, I, 426; *Zts. ang. Chem.* 1910, **23**, 768; *Chem. Ind. Jahr.* 1910, **33**, 186; *Wag. Jahr.* 1910, **56**, II, 433; *Chem. Zts.* 1910, **9**, 1986, 1988. Aust. P. 45765, 1909. Hung. Ann. N. 952, July 21, 1909. It. P. 108978, 1909. Belg. P. 198984, 198985, 1907; 217837, 1909.

gaseous HCl ,¹ other halogens,² sulfonyl chloride³ and chloro-sulfonic acids.⁴ Ethyl sulfuric acid⁵ and phenol sulfonic acids,⁶ have also been advocated. The formylcelluloses have been investigated by C. Cross and E. Bevan,⁷ E. Berl, and W. Smith,⁸ R. Woodbridge,⁹ Nitritfabrik Akt.,¹⁰ H. Deming,¹¹ Actien Gesell-

1. E. P. 2511, 1907, abst. J. S. C. I. 1907, **26**, 634; Jour. Soc. Dyers, 1907, **23**, 215. F. P. 376262, 1907, abst. J. S. C. I. 1907, **26**, 988; Mon. Sci. 1908, (4), **68**, 87. D. R. P. 189836, 189837, 1908; abst. Zts. ang. Chem. 1908, **21**, 268; Jahr. Chem. 1905-1908, II, 983; J. C. S. 1908, **94**, i, 321; Chem. Ind. 1907, **30**, 617.

2. E. P. 22237, 1911, F. P. 435507, 1911, abst. Mon. Sci. 1913, **78**, 133. Belg. P. 239564, 1911; abst. J. S. C. I. 1912, **31**, 279, 329.

3. U. S. P. 1051165, 1913, abst. Kunst. 1913, **3**, 275; J. S. C. I. 1913, **32**, 192. E. P. 24382, 1910, abst. J. S. C. I. 1911, **30**, 616; C. A. 1911, **5**, 3157. F. P. 423197, 1910, abst. J. S. C. I. 1911, **30**, 615; Chem. Tech. Rep. 1911, **35**, 307. Swiss P. 54497, 1910. Belg. P. 229995, 1910.

O. Bonhoeffer, H. Guntrum and Farf. v. Bayer & Co., D. R. P. 237765, 1909 (zinc chloride and sulfonyl chloride), and D. R. P. 237766, 1909 (zinc chloride and chlorosulfonic acid). U. S. P. 1093247, 1914, F. P. 422542, 1910, abst. J. S. C. I. 1911, **30**, 532, 1914, **33**, 546.

4. F. P. 430606, 1911; abst. J. S. C. I. 1911, **30**, 1375, Mon. Sci. 1913, **78**, 127.

5. U. S. P. 994738, 1911, abst. J. S. C. I. 1911, **30**, 888. E. P. 1556, 1911; abst. J. S. C. I. 1911, **30**, 1236, 1309; C. A. 1912, **6**, 1853. F. P. 427445, 1911, abst. J. S. C. I. 1911, **30**, 1051. D. R. P. 237210, 1910, abst. Zts. ang. Chem. 1911, **24**, 1837; Chem. Zentr. 1911, **82**, II, 497; Chem. Ind. 1911, **34**, 535. Belg. P. 233876, 1911. Aust. Ann. A-2376, Mar. 16, 1911; abst. Chem. Ztg. 1912, **36**, 252.

6. E. P. 29216, 1910, 309, 1911. F. P. 423774, 1910, abst. Mon. Sci. 1913, **78**, 31. F. P. 424621, 1911, D. R. P. 249535, 1910; Aust. P. 54512, 1912. Hung. P. 3096, 1910. Swiss P. 53777, Belg. P. 231853, 1911; Can. P. 134164, 1911, abst. J. S. C. I. 1911, **30**, 484, 615, 741, 888; C. A. 1911, **5**, 3340, 1912, **6**, 3188; Kunst. 1912, **2**, 255, 393.

7. J. C. S. 1911, **93**, 1450-1456; abst. J. S. C. I. 1911, **30**, 1008; C. A. 1911, **5**, 3568; Chem. Zentr. 1911, **82**, II, 855-6; Zts. ang. Chem. 1911, **24**, 2684; Chem. News, 1911, **103**, 295.

8. Ber. 1907, **40**, 903-908, abst. J. C. S. 1908, **94**, i, 505; J. S. C. I. 1908, **27**, 534; C. A. 1909, **3**, 838.

9. J. A. C. S. 1909, **31**, 1070, abst. J. C. S. 1909, **96**, i, 768; Bull. Soc. Chim. 1910, (4), **8**, 823; Zts. ang. Chem. 1910, **23**, 144; Jahr. Chem. 1909, **62**, II, 384; J. S. C. I. 1909, **28**, 1061; C. A. 1910, **4**, 667.

10. U. S. P. 953677, 955082, 1910, abst. J. S. C. I. 1910, **29**, 557; Mon. Sci. 1910, (4), **73**, 131. E. P. 17036, 1909, abst. J. S. C. I. 1910, **29**, 1005. F. P. 405293, 1909, abst. J. S. C. I. 1910, **29**, 417; Mon. Sci. 1910, (4), **73**, 171; Chem. Tech. Rep. 1910, **34**, 75. D. R. P. 219162, 219163, 1907, abst. Jahr. Chem. 1910, **63**, I, 426; Zts. ang. Chem. 1910, **23**, 763; Chem. Ind. 1910, **33**, 186; Wag. Jahr. 1910, **56**, II, 433; Chem. Zts. 1910, **9**, 1986, 1988. Aust. P. 45765, 1909. Hung. Ann. N-952, July 21, 1909. It. P. 103978, 1909. Belg. P. 198984, 198985, 1907, 217837, 1909.

11. J. A. C. S. 1911, **33**, 1519, abst. J. S. C. I. 1911, **30**, 1111; J. C. S. 1911, **100**, i, 771; C. A. 1911, **5**, 3678; Chem. Zentr. 1911, **82**, II, 1434. He found that a mixture of 30 cc. formic acid sp. gr. 1.22, 70 cc. hydrochloric acid sp. gr. 1.40 and 10 gm. calcium chloride will dissolve 1.5 gm. cellulose within 15 minutes, while a mixture of the two acids alone will affect no solution in 24 hours.

schaft f. Anilin Fabrikation,¹ Vereinigte Glanzstoff Fabriken,² E. Friedmann³ and G.⁴ Bonwitt.⁴

The solvents of cellulose formate are limited, and include lactic acid,⁵ formic and lactic acids,⁶ phosphoric acid,⁵ and inorganic salts.⁶ Phenols⁹ and chloral¹⁰ have been used to a limited extent only.

Processes for the commercial utilization of cellulose formate

1. E. P. 22237, 1911, abst. J. S. C. I. 1912, **31**, 279. See also ther. E. P. 1156, 1914, F. P. 461058, 1913.
F. P. 435507, 1911, Belg. P. 236564, 1911, abst. J. S. C. I. 1912, **31**, 329.
D. R. P. 237765, 237766, 1909, abst. Wag. Jahr. 1911, **57**, II, 420.
E. P. 24980, 1910, F. P. 422542, 1910, abst. Mon. Sci. 1913, **78**, 116. Aust. P. 8776, Nov. 11, 1910, abst. J. S. C. I. 1911, **30**, 532, 1112, C. A. 1912, **6**, 1672. Aust. P. 52289, abst. Kunst. 1913, **3**, 27.
E. P. 24382, 1910, F. P. 423197, 1910, abst. Mon. Sci. 1913, **78**, 117.
Swiss P. 54497, 1910. Belg. P. 239995, 1910, abst. J. S. C. I. 1911, **30**, 615, 616; C. A. 1911, **5**, 3157, Chem. Tech. Rep. 1911, **35**, 407.
2. U. S. P. 1046729, 1912, 1055713, 1913, abst. Mon. Sci. 1913, **78**, 151, C. A. 1913, **7**, 700, 1608. E. P. 15700, 1910, E. P. 6241, 1911, being addition to E. P. 15700, 1910, F. P. 420856, 1910, First Addition thereto dated Mar. 13, 1911, D. R. P. 233589, 1909, abst. Wag. Jahr. 1911, **57**, II, 421. D. R. Ann. B-60304, V-8974, V-9653, abst. Kunst. 1913, **3**, 479.
Belg. P. 234433, 1911, Aust. P. A-5148, 1910, 2994, 1911, Swiss P. 53585, 1910, 56146, 1911, Hung. Ann. G-3306, 1911, Ital. P. 115772, 1911, abst. J. S. C. I. 1910, **29**, 1199, 1911, **30**, 279, 1050, 1912, **31**, 279.
3. U. S. P. 994738, 1911, E. P. 1556, 1911, F. P. 427425, 1911, D. R. P. 237210, 1910, Belg. P. 233786, 1911, Aust. Ann. A-2376, 1911, abst. J. S. C. I. 1911, **30**, 888, 1051, 1236, 1309, Chem. Ztg. 1912, **36**, 292.
4. U. S. P. 804960, 1905, E. P. 6751, 1905, F. P. 352897, 1905, D. R. P. 175379, 1904, 188542, 1905.
5. Vereinigte Glanzstoff Fabriken A. G., E. P. 8313, 1911, F. P. 428009, 1911, abst. J. S. C. I. 1911, **30**, 1150, 1156.
U. S. P. 690211, 1901. See also Furst Guido Domersmarck'sche Kunstseiden und Acetatwerke, D. R. P. 237599, 1907, U. S. P. 922340, 1909, E. P. 6554, 1909, F. P. 400652, 1909.
6. Vereinigte Glanzstoff Fabriken A. G., D. R. P. 239701, 1910. See also D. R. P. 151918, 189703, 220228. J. Benberg A. G., D. R. P. 198985, 1907.
7. Vereinigte Glanzstoff Fabriken A. G., E. P. 29246, 1910, E. P. 309, 1911, F. P. 423774, 1910, F. P. 424621, 1911, D. R. Ann. 39b, V-9653, 1910, Aust. P. 39b, A-9872, 1910, E. P. 3096, 1910, Swiss P. 53777, abst. J. S. C. I. 1911, **30**, 448, 615, 741, 888, C. A. 1911, **5**, 3340, Kunst. 1912, **2**, 255.
E. Bronnert, U. S. P. 1029341, 1912, abst. J. S. C. I. 1912, **31**, 637, Mon. Sci. 1912, **77**, 164, E. P. 8313, 1911, abst. J. S. C. I. 1911, **30**, 1050, Chem. Tech. Rep. 1911, **35**, 556, 1912, **36**, 532, C. A. 1912, **6**, 3018. F. P. 428069, 1911, abst. J. S. C. I. 1911, **30**, 1156. Aust. Appl. 2694, 1911.
8. D. R. P. 265852, 265911, 1913, 266600, 267557, 1913. D. R. Ann. V-9693.
9. Internationale Celluloseester Ges., D. R. P. 265852, 1913, D. R. P. Ann. D-23897, J-15341, 15342, L-27805, abst. J. S. C. I. 1913, **32**, 1104; C. A. 1914, **8**, 573.
10. Internationale Celluloseester Ges., D. R. P. 265911, 1913; abst. J. S. C. I. 1913, **32**, 1104, Kunst. 1913, **3**, 474. D. R. P. 266600 and Addn. 267557 thereto.

have been described by E. Thomson and J. Callan,¹ C. Ellis,² Chemische Fabrik von Heyden Aktiengesellschaft,³ J. P. Bernberg Aktiengesellschaft,⁴ E. Worden,⁵ and Vereinigte Glanzstoff Fabriken Akt. Ges.⁶

Carbohydrate phosphates,⁷ cellulose propionates,⁸ butyrates⁹

1. U. S. P. 895127, 1902; Re. 11997, 1902.
2. U. S. P. 999490, 1911; abst. J. S. C. I. 1911, **30**, 1051.
3. E. P. 3973, 1911; F. P. 426436, 1911; Aust. Ann. A-327, 1911; abst. J. S. C. I. 1911, **30**, 950, 1156.
4. E. P. 2511, 1907; F. P. 276262, 1907; D. R. P. 189836, 189837, 1908; abst. J. C. S. 1908, **94**, i, 321; J. C. S. I. 1907, **26**, 634, 988; Chem. Zentr. 1908, **79**, I, 320; C. A. 1907, **1**, 2191; 1908, **2**, 1508.
5. J. S. C. I. 1912, **31**, 1064-84 Reprinted Chem. Eng. 1913, **17**, 26. Reprinted Mon. Sci. 1913, **78**, (5), **3**, 388; abst. C. A. 1913, **7**, 888, 2304; Chem. Zentr. 1913, **84**, I, 1105; J. C. S. 1913, **104**, i, 19.
6. Belg. P. 231279, 1910. Aust. P. Ann. 9782, 1910. Swiss P. 53585, 1910, 56146, 1911; Aust. Ann. 9782, 1910; 2275, 1911; abst. Chem. Ztg. 1912, **36**, 478; 1913, **37**, 481. E. Bronnert, U. S. P. 1153596, 1915; F. P. 423774, 1910, abst. C. A. 1915, **9**, 3129; J. S. C. I. 1911, **30**, 615; 1915, **34**, 1049.
7. Aktiebolaget "Astra," D. R. P. 203864, 1912; Dan. P. 18904, 1912; abst. C. A. 1915, **9**, 2424; 1917, **11**, 2581. F. Bayer & Co., D. R. P. 292817, 1915; abst. C. A. 1917, **11**, 1519; J. S. C. I. 1916, **35**, 1082. S. Carlson, E. P. 11653, 1913.
8. U. S. P. 632605, 1899. E. P. 22029, 1898; abst. J. S. C. I. 1899, **18**, 756. Can. P. 63101, 1899. D. R. P. 112817. Russ. P. 3264, 1900. Belg. P. 137577, 1898. Dan. P. 2558, 1899. Port. P. 2930, 1899. Belg. P. 137577.
9. D. R. P. 203178, 1906, abst. Jahr. Chem. 1905-1908, II, 384; Chem. Zentr. 1908, **79**, II, 1549; Chem. Zts. 1909, **8**, 1053; Mon. Sci. 1912, **77**, 97; Zts. ang. Chem. 1908, **21**, 2426; Wag. Jahr. 1908, **54**, II, 366. D. R. P. 206950, 1907, being Addition to D. R. P. 203178; abst. Chem. Zts. 1909, **8**, 1183; Zts. ang. Chem. 1909, **22**, 656; Chem. Ind. 1909, **32**, 153; Wag. Jahr. 1909, **55**, II, 397; Mon. Sci. 1912, **77**, 96. E. P. 2026-A, 1907; abst. J. S. C. I. 1908, **27**, 353.
10. D. R. P. 222450, 1908, abst. J. S. C. I. 1910, **29**, 811; Zts. ang. Chem. 1910, **23**, 1389; Wag. Jahr. 1910, **56**, II, 434; Chem. Zentr. 1910, **81**, I, 48; Chem. Zts. 1910, **9**, 1902; C. A. 1910, **4**, 2875.
11. U. S. P. 891218, 1908, abst. J. S. C. I. 1908, **27**, 765; Mon. Sci. 1909, (4), **70**, 116. E. P. 2026-B, 1907; abst. J. S. C. I. 1908, **27**, 353. F. P. 373994, 1907; abst. J. S. C. I. 1907, **26**, 776; Mon. Sci. 1908, (4), **68**, 83; Chem. Tech. Rep. 1907, **31**, 302. D. R. P. 201233, 1906; abst. Chem. Zts. 1908, **7**, 993; Zts. ang. Chem. 1908, **21**, 2233; Chem. Zentr. 1908, **79**, II, 994; Chem. Ind. 1908, **31**, 587; Jahr. Chem. 1905-1908, II, 982. D. R. P. 203178, 1906; abst. Chem. Zts. 1909, **8**, 1053; Zts. ang. Chem. 1908, **21**, 2426; Chem. Zentr. 1908, **79**, II, 1549; Jahr. Chem. 1905-1908, II, 984; Chem. Ind. 1908, **31**, 741. Aust. P. 41831.
12. E. P. 14255, 1906; abst. J. S. C. I. 1907, **26**, 220; C. A. 1907, **1**, 1341. F. P. 368738, 1906; abst. J. S. C. I. 1907, **26**, 30. D. R. P. 198482, 1905; abst. Mon. Sci. 1911, (5), **74**, 54; Zts. ang. Chem. 1908, **21**, 1760; Chem. Zentr. 1908, **79**, II, 118; Jahr. Chem. 1905-1908, II, 982; Chem. Ind. 1908, **31**, 378.
13. U. S. P. 999236, 1911; abst. J. S. C. I. 1911, **30**, 1050. E. P. 3103, 1907; abst. J. S. C. I. 1907, **26**, 889. F. P. 374370, 1907; abst. J. S. C. I. 1907, **26**, 776; Mon. Sci. 1908, (4), **68**, 84; Chem. Zts. 1907, **8**, 139. F. P. 430606, 1911; abst. J. S. C. I. 1911, **30**, 1375. F. P. 385179, 1907; abst.

and phthalates are known, but have no industrial application.

The cellulose acetonitrates (nitracetates) are not a definitely characterized series of esters. They have, in the main, been put forward as combinations reducing the inflammability of nitro-cotton. This class of bodies has been described by C. Haussermann,¹ L. Lederer,² E. Berl and W. Smith,³ J. Schmerber and L.

- J. S. C. I. 1908, **27**, 589; C. A. 1909, **3**, 2383; Mon. Sci. 1909, (4), **70**, 100; Bull. Soc. Chim. 1909, (4), **6**, 557; F. P. 385180, 1907, abst. Mon. Sci. 1909, (4), **70**, 105; Bull. Soc. Chim. 1909, (4), **6**, 557; U. S. P. 695127, 1902, Re. 11997, 1902; E. P. 2264, 1902; abst. J. S. C. I. 1903, **22**, 303; Zts. ang. Chem. 1913, **26**, 673; abst. J. S. C. I. 1913, **32**, 1102; J. A. C. S. 1909, **31**, 1069; abst. Zts. ang. Chem. 1910, **23**, 144; J. C. S. 1909, **96**, i, 768; J. S. C. I. 1909, **28**, 1061; C. A. 1910, **4**, 667; Chem. Zentr. 1909, **80**, J. 1216. For descriptive review of the propionates, including the esters, see A. Duboscq, Rev. gen. chim. 1910, **12**, 333; A. Polotsky, U. S. P. 1296847, abst. C. A. 1919, **13**, 1637; Verein für Chemische Industrie in Mainz, Swiss P. 66047, abst. Kunst. 1915, **5**, 95.
9. U. S. P. 884475, 1908; abst. J. S. C. I. 1908, **27**, 512; Can. P. 136538, 1911; abst. C. A. 1912, **6**, 303; E. P. 11728, 1911, abst. C. A. 1912, **6**, 3183; E. P. 24662, 1898; abst. J. S. C. I. 1900, **19**, 375. For the sebacic esters of cellulose, see Knoll & Co., D. R. P. 203642, 1906; Zts. ang. Chem. 1908, **21**, 1760, 2334; U. S. P. 695127, 1902, Re. 11997, 1902; E. P. 2264, 1902; abst. J. S. C. I. 1903, **22**, 303; U. S. P. 776192, 776180, 1904, abst. J. S. C. I. 1904, **23**, 1223; F. P. 375092, 1907, abst. J. S. C. I. 1907, **26**, 877; U. S. P. 779553, 1905; abst. J. S. C. I. 1905, **24**, 139; D. R. P. 152630, 1904; Jahr. Chem. 1904, **57**, I, 239; U. S. P. 1025731, 1912, abst. C. A. 1912, **6**, 1994; E. P. 12406, 1910, abst. J. S. C. I. 1911, **30**, 206; D. R. P. 242786, 1910; abst. C. A. 1912, **6**, 2182; F. P. 385179, 1907, abst. Mon. Sci. 1909, (4), **70**, 105; Bull. Soc. Chim. 1909, (4), **6**, 557; J. S. C. I. 1908, **27**, 589; C. A. 1909, **3**, 2383; F. P. 385180, 1907, abst. Mon. Sci. 1909, (4), **70**, 106; Bull. Soc. Chim. 1909, (4), **6**, 557; J. S. C. I. 1908, **27**, 589; C. A. 1909, **3**, 2383; F. P. 430606, 1911, abst. J. S. C. I. 1911, **30**, 1375; U. S. P. 632605, 1899; E. P. 22029, 1898, abst. J. S. C. I. 1899, **18**, 750; Can. P. 63101, 1899; D. R. P. 112817, abst. Jahr. Chem. 1900, **53**, 843; Wag. Jahr. 1900, **46**, II, 450; Russ. P. 3264, 1900; Belg. P. 137577, 1898; Dan. P. 2558, 1899; Port. P. 2930, 1899; cf. D. R. P. 105347; Wag. Jahr. 1899, **45**, 1064; U. S. P. 999236, 1911; abst. J. S. C. I. 1911, **30**, 1050; E. P. 3103, 1907; abst. J. S. C. I. 1907, **26**, 889; F. P. 374370, 1907; abst. J. S. C. I. 1907, **26**, 776; Mon. Sci. 1908, (4), **68**, 84; Chem. Zts. 1907, **6**, 139. For sebacic esters of hydrocellulose, see A. Stein, Dissertation, Dresden, 1911, p. 71; U. S. P. 695127, 1902; Re. 11997, 1902; E. P. 2264, 1902; abst. J. S. C. I. 1903, **22**, 303; Also U. S. P. 632605, 1899; E. P. 22029, 1898; abst. J. S. C. I. 1899, **18**, 756; Can. P. 63101, 1899; D. R. P. 112817, 1898; Russ. P. 3264, 1900; Belg. P. 137577, 1898; Dan. P. 2558, 1899; Port. P. 2930, 1899; E. P. 22237, 1911; abst. J. S. C. I. 1912, **31**, 279; F. P. 435507, 1911; abst. J. S. C. I. 1912, **31**, 329; Belg. P. 230564, 1911; R. P. 8646, 8647, 1910; abst. J. S. C. I. 1911, **30**, 533, 616; Chem. Tech. Rep. 1911, **35**, 307; F. P. 413657, 413658, 1910; abst. J. S. C. I. 1910, **29**, 1101, 1911, **35**, 307; F. P. 414679, 414680, 1910; abst. J. S. C. I. 1910, **29**, 1199, 1228; Swiss P. 51644, 51910; abst. Kunst. 1912, **2**, 77, 99; Belg. P. 223996, 1910; Aust. P. 47244, 53109; abst. Kunst. 1912, **2**, 255; E. P. 22237, 1911; abst. J. S. C. I. 1912, **31**, 279; F. P. 435507, 1911; abst. J. S. C. I. 1912, **31**, 329; Belg. P. 239564, 1911.
1. Chem. Ztg. 1905, **29**, 667; abst. J. S. C. I. 1905, **24**, 748; Jahr. Chem. 1905-1908, II, 983; Zts. ang. Chem. 1905, **18**, 1880; Chem. Centr.

Morane,¹ F. Meyer,² A. Pictet,³ E. Zuehl,⁴ D. Florentin,⁵ Aktien-
gesellschaft für Anilin Fabrikation,⁶ H. Nishida,⁷ H. Dreyfus,⁸

1905, **76**, II, 760, J. C. S. 1905, **88**, 574, Wag. Jahr 1905, **51**, II, 192.

² U. S. P. 1028748, 1912; abst. J. S. C. I. 1912, **31**, 637, Mon. Sci. 1912, **77**, 164. E. P. 19107, 1906, abst. J. S. C. I. 1907, **26**, 220. F. P. 368766, 1906, abst. J. S. C. I. 1907, **26**, 30. F. P. 402072, 1909; abst. Mon. Sci. 1911, (5), **74**, 153. D. R. P. 179947, 1905, abst. C. A. 1906, **1**, 1507; J. S. C. I. 1907, **26**, 889, Zts. ang. Chem. 1907, **20**, 1194; Mon. Sci. 1909, (4), **70**, 68; Jahr. Chem. 1905-1908, II, 433; Chem. Zentr. 1907, **78**, I, 433; Wag. Jahr. 1907, **53**, I, 419. D. R. P. 200149, 1905, being Addition to D. R. P. 179947; abst. Zts. ang. Chem. 1908, **21**, 2047, Wag. Jahr. 1908, **54**, II, 365; Chem. Zentr. 1908, 557, Jahr. Chem. 1905-1908, II, 986. D. R. P. 210778, 1906, abst. Chem. Zentr. 1909, **80**, II, 247, Chem. Zts. 1909, **8**, 1474, Zts. ang. Chem. 1909, **22**, 162Q, Chem. Ind. 1909, **32**, 383, Jahr. Chem. 1909, **62**, II, 389, Wag. Jahr. 1909, **55**, II, 390. E. P. 19107, 1906, F. P. 368766. D. R. P. 179947, cover the same ground, i. e., the treatment of nitrocellulose either with acetic anhydride or acetyl chloride, perhaps in the presence of carbon tetrachloride. D. R. P. 200149 adds treatment with glacial acetic acid, while U. S. P. 1028748, F. P. 402072; D. R. P. 210778, denitrates the mixed aceto-nitrate to decrease the inflammability. E. P. 11625, 1909; abst. J. S. C. I. 1909, **28**, 1030. F. P. 402072, 1909; abst. J. S. C. I. 1909, **28**, 1221. D. R. P. 240751, 1908; abst. C. A. 1912, **6**, 2179, Kunst. 1912, **2**, 15, Chem. Zentr. 1911, **81**, I, 1843, Zts. ang. Chem. 1912, **25**, 47; Chem. Ztg. 1911, **35**, 624, Chem. Ind. 1911, **34**, 793. D. R. P. 248559, 1909, being Addition to D. R. P. 240751, 1908; abst. Kunst. 1912, **2**, 296, Zts. ang. Chem. 1912, **25**, 1884, C. A. 1912, **6**, 2849, Chem. Tech. Rep. 1912, **36**, 437, Chem. Zentr. 1912, **83**, II, 305.

³ Ber. 1907, **40**, 903, abst. J. S. C. I. 1907, **26**, 273, C. A. 1907, **1**, 2179, J. C. S. 1907, **92**, 289, Chem. Tech. Rep. 1907, **31**, 257, Jahr. Chem. 1905-1908, VI, 982, Zts. ang. Chem. 1908, **21**, 1185. See also Berl and Smith, J. S. C. I. 1908, **27**, 534, abst. Jahr. Chem. 1905-1908, II, 985, Zts. ang. Chem. 1908, **21**, 2427. Ost, Zts. ang. Chem. 1906, **19**, 922. Green and Perkin, J. C. S. 1906, **89**, 811. Pictet and P. Genequand, Ber. 1902, **35**, 2526. Berl and Smith, Ber. 1908, **41**, 1837, abst. J. C. S. 1908, **94**, i, 505, Bull. Soc. Chim. 1909, (4), **6**, 499, Zts. ang. Chem. 1908, **21**, 1855, 2427.

⁴ E. P. 4863, 1903; abst. J. S. C. I. 1904, **23**, 382. F. P. 324121, 1902, abst. J. S. C. I. 1904, **23**, 569.

⁵ D. R. P. 210519, 1907, abst. J. S. C. I. 1909, **28**, 812, Zts. ang. Chem. 1909, **22**, 1620.

⁶ D. R. P. 200201, 1907, abst. J. S. C. I. 1912, **31**, 958, Zts. ang. Chem. 1908, **21**, 2103, Chem. Zentr. 1908, **79**, II, 552, Jahr. Chem. 1905-1908, 359, Chem. Tech. Rep. 1908, **32**, 434, Wag. Jahr. 1908, **54**, II, 15.

⁷ U. S. P. 729990, 1903, abst. J. S. C. I. 1903, **22**, 817. D. R. P. 162239, 1902, abst. Zts. ang. Chem. 1906, **19**, 498, Chem. Zentr. 1905, **76**, II, 1000.

⁸ F. P. 445798, 1912, abst. Kunst. 1913, **3**, 274, Mon. Sci. 1913, **78**, 143.

⁹ F. P. 449253, 1912; abst. Kunst. 1913, **3**, 196, J. S. C. I. 1913, **32**, 482; Mon. Sci. 1914, **80**, 5. E. P. 10706, 1912; abst. J. S. C. I. 1913, **32**, 597. In their E. P. 1156, 1914; Add. to E. P. 10706, 1912; abst. J. S. C. I. 1914, **33**, 688, cellulose derivatives made by the action of more or less concentrated nitric acid on cellulose, are treated by the usual methods of esterification for producing cellulose esters. E. P. 5633, 1914; Swiss P. 68921; Add. to 61710; Holl. P. 1476, 1916; Aust. P. 67942; abst. C. A. 1916, **10**, 2637; Kunst. 1914, **4**, 44; 1915, **5**, 203. Swiss P. 61424, 1912, Chem. Ztg. 1913, **37**, 1052.

¹⁰ Kunst. 1914, **4**, 141; abst. J. S. C. I. 1914, **33**, 476; C. A. 1914, **8**,

J. Koetschet and M. Theumann,¹ and C. Hake and R. Lewis.²

The cellulose acetosulfates³ and benzoates⁴ are of no present value.

- 2250 8. E. P. 20975, 1911, F. P. 432264, 1911, abst. J. S. C. I. 1912, **31**, 24; 1913, **32**, 19, Kunst 1914, **4**, 360.
1. U. S. P. 1286025, 1918; E. P. 8046, 1915, abst. C. A. 1919, **13**, 261; J. S. C. I. 1916, **35**, 39; 1919, **38**, 102 A.
2. J. S. C. I. 1905, **24**, 374, Zts. ang. Chem. 1905, **18**, 1988, Jahr. Chem. 1905-1908, 975, J. C. S. 1905, **88**, 512.
3. Ber. 1905, **38**, 185, abst. J. S. C. I. 1905, **24**, 685, Jahr. Chem. 1905-1908, II, 986; Bull. Soc. Chim. 1906, (3), **36**, 638, J. C. S. 1905, **88**, 512, Chem. Centr. 1905, **76**, II, 36, Wag. Jahr. 1905, **51**, II, 399. Cross, Bevan and Briggs, Ber. 1905, **38**, 3531, abst. J. S. C. I. 1905, **24**, 1251, Zts. ang. Chem. 1906, **19**, 1267, Chem. Centr. 1905, **76**, II, 1625, Bull. Soc. Chim. 1906, (3), **36**, 639, Jahr. Chem. 1905-1908, II, 986, J. S. C. I. 1905, **24**, 374, abst. Zts. ang. Chem. 1905, **18**, 1988, Jahr. Chem. 1905-1908, 975, Chem. Centr. 1905, **76**, 1702, J. C. S. 1905, **88**, 512. D. R. P. 200334, 1907, abst. J. S. C. I. 1908, **27**, 1130, C. A. 1908, **2**, 2456, Mon. Sci. 1911, (5), **74**, 63, Chem. Zts. 1908, **7**, 909, Zts. ang. Chem. 1908, **21**, 2233, Chem. Zentr. 1908, **79**, II, 655, Jahr. Chem. 1905-1908, II, 987, J. C. S. 1908, **94**, i, 955, Chem. Ind. 1908, **31**, 499, Wag. Jahr. 1908, **54**, II, 363. For the formation of cellulose solutions by the action of concentrated cooled sulfuric acid upon cellulose, see E. Berl, F. P. 454753, 1913. D. R. P. 259248, 1912, abst. J. S. C. I. 1913, **32**, 653, 865. Belg. P. 253945, 1913, abst. Kunst 1913, **3**, 355, C. A. 1913, **7**, 3026. See also this vol., p. 92.
4. Cross and Bevan, J. C. S. 1893, **26**, 837, Chem. News, 1890, **61**, 87. Cross, Bevan and Jenks, Ber. 1901, **34**, 2496. Baumann, Ber. 1886, **19**, 3218. Compt. rend., 1875, **81**, 1105, abst. Chem. Centr. 1876, **47**, 83, Jahr. Chem. 1875, **75**, 786, Bull. Soc. Chim. 1876, **26**, 190, J. C. S. 1876, **30**, 696, J. C. S. 1899, **55**, 449, abst. Jahr. Chem. 1889, **42**, 2063, Mon. Sci. (4), **3**, 1284, Chem. Centr. 1889, **60**, II, 124, Bull. Soc. Chim. 1889, **2**, 682, Chem. News, 1891, **63**, 66, abst. J. C. S. 1891, **60**, 690, Chem. Centr. 1891, **62**, II, 620, Jahr. Chem. 1891, **44**, 2181, Monatsh. **10**, 389. O. Hauser and H. Muschner, Zts. ang. Chem. 1913, **26**, 437, J. S. C. I. 1913, **32**, 357, Chem. Zentr. 1913, **84**, I, 1412, Jour. Dyers and Col. 1913, **29**, 194, Kunst 1913, **3**, 330, C. A. 1913, **7**, 2854, J. C. S. 1913, **104**, i, 363. Cross and Bevan, Ber. 1901, **34**, 1514, J. C. S. 1901, **80**, i, 452, Chem. Centr. 1901, **72**, II, 94, Jahr. Chem. 1901, **54**, 891. J. Briggs, Zts. ang. Chem. 1913, **26**, 255, Chem. Zentr. 1913, **84**, I, 2110, Jour. Dyers and Col. 1913, **29**, 194, Kunst 1913, **3**, 330, C. A. 1913, **7**, 2855, J. S. C. I. 1913, **32**, 595, J. C. S. 1913, **104**, 504, H. Ost and F. Klem, Zts. ang. Chem. 1913, **26**, 437, J. S. C. I. 1913, **32**, 823, Kunst 1913, **3**, 331, C. A. 1913, **7**, 3661, J. C. S. 1913, **104**, i, 1043, Chem. Zentr. 1913, **85**, II, 1293. D. R. P. 139669, abst. Jahr. Chem. 1903, 1014, Chem. Ind. 1903, **26**, 167, Wag. Jahr. 1903, **49**, II, 418, Zts. ang. Chem. 1903, **16**, 285, Chem. Centr. 1903, **74**, I, 744. See also D. R. P. 243581, 1908; abst. J. S. C. I. 1912, **31**, 381, C. A. 1912, **6**, 2316, Chem. Tech. Rep. 1912, **36**, 196, Wag. Jahr. 1912, **58**, II, 17, Zts. ang. Chem. 1912, **25**, 654, Chem. Ind. 1912, **35**, 190, Chem. Zentr. 1912, **83**, I 695. E. P. 2527, 1912. A. Nastukoff (Jour. Russ. Phys. Chem. Soc. 1902, **34**, 231, 505; abst. Chem. Centr. 1902, **73**, I, 1277, II, 576, Jahr. Chem. 1902, **55**, 1054, 1142, J. C. S. 1902, **82**, i, 362, 747; Bull. Soc. Chim. 1902, (3), **28**, 130, 481), has described a tetraphenyl cellulose, prepared by allowing benzol to act upon a solution of cellulose in concentrated sulfuric acid. By addition of ice a sulfured tetraphenyl derivative is precipitated, insoluble in all solvents, but which like cellulose, gives nitro products. E. P. 24662, 1898, abst. J. S. C. I. 1900, **19**, 375. E. P. 22237, 1911, abst. J. S. C. I. 1912, **31**, 279. F. P. 435507, 1911, abst. J. S. C. I. 1912, **31**, 329. Belg. P. 239564, 1911. F. P. 375092,

technical importance, on account of their deficient stability.

The properties of cellulose acetate have recently been reported upon by H. Ost,¹ E. Worden² and C. Cross and E. Bevan.³ The recovery of cellulose acetate from various sources has engaged the attention of Soc. Generale du Coton Industrielle,⁴ J. Lumsden and R. MacKenzie,⁵ and G. Miles.⁶ The Elektro-Osmose A. G.⁷ proposes to purify cellulose acetate by the action of an electric current.

Cellulose Acetate Solvents and Plastifiers. Advances in unflammable cellulose esters technology has followed the trend of nitrocellulose advancement, in that decided progress has followed those periods when new solvents were discovered, or improved ways of utilizing those then known. Tetrachlorethane, trichlorethylene, dichlorethylene and other chlorine substituted ethane and ethylene compounds have been used to a considerable extent as cellulose acetate softeners and solvents.⁸ Details of their preparation and application are to be found in the publications of L. Lederer,⁹ G. Mersereau,¹⁰ H. Weiser and G. Wightman,¹¹ A. Voigt,¹² C. Acker,¹³ R. Ashton and Calico Printers Association,¹⁴ J. Aylsworth,¹⁵ Badische Anilin u Soda Fabrik,¹⁶ G.

1907; abst. J. S. C. I. 1907, **26**, 877. U. S. P. 695127, 1902; Reissue 11997, 1902. E. P. 2264, 1902; abst. J. S. C. I. 1903, **22**, 303. U. S. P. 999490, 1911, abst. J. S. C. I. 1911, **30**, 1051.

1. Zts. ang. Chem. 1919, **32**, 66, 76, 82; abst. J. S. C. I. 1919, **33**, 355-A.

2. J. S. C. I. 1919, **38**, 370-T; abst. C. A. 1920, **14**, 1038; Chem. Zentr. 1920, **91**, II, 303.

3. J. Soc. Dyers Color. 1920, **36**, 19.

4. F. P. Appl. 103588, 1918.

5. E. P. Appl. 2365, 1918; abst. J. S. C. I. 1918, **37**, 111-A.

6. U. S. P. 1196799, 1916; abst. C. A. 1916, **12**, 2853.

7. D. R. P. 296053, 1914; abst. J. S. C. I. 1917, **36**, 593.

8. For details of the application of these solvents, see E. Worden, Technology of Cellulose Esters, 1915, **8**, 2719. See also Bayer. Ind. Gewerbebl. 1918, 255; abst. Kunst. 1919, **9**, 164.

9. D. R. P. 175379; Aust. P. 29219, 1907.

10. U. S. P. 1308803, 1919; abst. C. A. 1919, **13**, 2278.

11. J. Phys. Chem. 1919, **23**, 415.

12. Chem. Apparatus, 1917, **4**, 177, 188; abst. Chem. Zentr. 1918, **89**, I, 393.

13. U. S. P. 891896, 1908; Swiss P. 36058, 1906; abst. J. S. C. I. 1908, **27**, 833.

14. E. P. 23324, 1911.

15. U. S. P. 1078030, 1913; 1094830, 1914; 1154161, 1915; abst. C. A. 1914, **8**, 2268; 1915, **9**, 3119; J. S. C. I. 1914, **33**, 604.

16. E. P. 19764, 1912. Holl. P. 96, 1914; abst. C. A. 1914, **8**, 2457.

Baillio,¹ C. Blanc,² Boehringer & Soehne,³ Chemische Fabrik Griesheim Elektron,⁴ C. Coffignier,⁵ L. Coleman,⁶ C. Combes,⁷ Commercial Research Co.,⁸ Compagnie des produits Chimiques et de la Camargue,⁹ Consortium f. Elektrochemische Industrie,¹⁰ H. Dreyfus,¹¹ du Pont de Nemours & Co.,¹² B. Eldred,¹³ C. Ellis,¹⁴ W. Elsner,¹⁵ G. Ferguson,¹⁶ J. Filhol,¹⁷ R. Gowdy,¹⁸ V. Harding,¹⁹ F. Harris,²⁰ P. Hildebrand,²¹ G. Jones and V. Allison,²² T. Kerfoot, E. Kerfoot, J. Irvine and W. Haworth,²³ The Kwagaku Toyō Kabushiki Kaisha,²⁴ B. Lacy,²⁵ G. Lepine,²⁶ J. Lidholm,²⁷ L. Lilienfeld,²⁸ K. McElroy,²⁹ F. Matthews and E. Strange,³⁰ F.

1. U. S. P. 1260621, 1260622, 1918, abst. J. S. C. I. 1918, **37**, 349-A.
2. U. S. P. 1248065, 1917, abst. C. A. 1918, **12**, 279.
3. E. P. 18818, 1911.
4. F. P. 462711; D. R. P. 264883, 1908, 278249, 1912, Can. P. 107798, 1907; Aust. P. 35666, 1908, Norw. P. 17195, abst. C. A. 1914, **8**, 3221, 1915, **9**, 1096; Zts. ang. Chem. 1909, **22**, 214; Chem. Zentr. 1909, **80**, I, 325, Chem. Tech. Rep. 1909, **33**, 23; Wag. Jahr. 1908, **54**, II, 16, Chem. Zts. 1909, **8**, 1115.
5. Bull. Soc. Chim. 1914, **15**, 780, abst. C. A. 1915, **9**, 972.
6. U. S. P. 1233190, 1917, abst. C. A. 1917, **11**, 2411.
7. U. S. P. 735948, 1903, E. P. 25688, 1901, F. P. 312046, Add. 4260, Belg. P. 184426, 1905; Aust. P. 8752, 1902, abst. J. S. C. I. 1902, **21**, 1469; 1903, **22**, 1013.
8. E. P. 113954, 113955, abst. J. S. C. I. 1919, **38**, 396 A.
9. E. P. 132755, 132757, 1919, abst. J. S. C. I. 1919, **38**, 847-A, C. A. 1920, **14**, 285.
10. Belg. P. 216919, 1909, Aust. P. 31247, 1908, Chem. Ztg. 1908, **32**, 529; abst. J. S. C. I. 1908, **27**, 643.
11. U. S. P. 1181858, 1916, 1242783, 1917, abst. C. A. 1918, **12**, 224.
12. E. P. 879, 1913.
13. E. P. 118954, 1918, Can. P. 186634, 1918, abst. C. A. 1918, **12**, 2325; J. S. C. I. 1919, **38**, 512-A.
14. U. S. P. 1248638, 1917, F. P. 363506, 1906, abst. C. A. 1918, **22**, 412.
15. Chem. Ztg. 1917, **41**, 901, abst. C. A. 1918, **12**, 1967.
16. U. S. P. 1151256, 1915, 1270392, 1918, abst. C. A. 1915, **9**, 2795.
17. F. P. 476576, 1914, abst. J. S. C. I. 1916, **35**, 56.
18. U. S. P. 1318074, 1919, abst. J. S. C. I. 1919, **38**, 927-A.
19. E. P. 126511, 1918, abst. C. A. 1919, **13**, 2375. Can. P. 197046, 1920.
20. U. S. P. 1190160, 1190161, 1916, abst. J. S. C. I. 1916, **35**, 916.
21. E. P. 22707, 1913; abst. J. S. C. I. 1914, **33**, 1100.
22. J. Ind. Eng. Chem. 1919, **11**, 639, abst. C. A. 1919, **13**, 2011.
23. E. P. 128635, 1917; abst. J. S. C. I. 1919, **38**, 520-A.
24. Jap. P. 32030, 1918; abst. C. A. 1918, **12**, 2203.
25. U. S. P. 1263906, 1918, 1308760, 1919; E. P. 101708, 1916; abst. J. S. C. I. 1917, **36**, 1063, 1918, **37**, 443-A, 1919, **38**, 676-A.
26. U. S. P. 1235399, 1917; 1255618, 1918; abst. C. A. 1917, **11**, 2560; 1918, **12**, 882.
27. Aust. P. 31195, 1907.
28. Aust. P. 8825, 1910; 4803, 1911; abst. Chem. Ztg. 1913, **37**, 134.
29. U. S. P. 1255615, 1255616, 1255617, 1918; 1295339, 1315229; E.

Michel,¹ C. Netz & Co. and F. Koch,² G. Ornstein,³ H. Precht,⁴ Salzbergwerk Neustassfurt,⁵ S. Sastry,⁶ S. "Schwimmer,"⁷ Selden Co. and H. Gibbs,⁸ L. Smith,⁹ C. Strosacker,¹⁰ H. Tompkins,¹¹ G. Currier,¹² V. Veley,¹³ H. Walker,¹⁴ E. Zappi,¹⁵ and A. Zimmer.¹⁶

The foregoing references are to publications not cited in this series, Volume VIII.

Of the alcohols, ethyl alcohol is a non-solvent of not hydrated triacetylcellulose, and has been used as a precipitant,¹⁷ although

- P. 113955, 1918, Can. P. 186632, 1918, abst. C. A. 1918, **12**, 703, 2325; J. S. C. I. 1919, **38**, 339-A, 847-A.
30. E. P. 6897, 1914, 5075, 5074, 1915.
1. Zts. ang. Chem. 1906, **19**, 1095, abst. J. S. C. I. 1906, **25**, 713.
2. Belg. P. 261836, 1913.
3. Aust. Ann. 839, 1911, Swiss P. 55752, 1911. Chem. Ztg. 1912, **36**, 557.
4. U. S. P. 817188, 1906, F. P. 355776, 1905, abst. J. S. C. I. 1905, **24**, 1255; 1906, **25**, 443.
5. Aust. P. 29203, 1907, D. R. P. 174068. Salzbergwerk Neustassfurt and Teilnehmer, Ital. P. 377/159 122600, abst. Chem. Ztg. 1913, **37**, 32.
6. J. S. C. I. 1916, **35**, 450.
7. D. R. P. 273344, Add. to D. R. P. 234264, Swiss P. 69958, abst. Wag. Jahr. 1914, **60**, II, 456, Chem. Zentr. 1914, **85**, I, 1794, Zts. ang. Chem. 1914, **27**, 339, C. A. 1914, **8**, 2818.
8. E. P. 123341, 1917, abst. C. A. 1919, **13**, 1478.
9. Zts. physik. Chem. 1918, **92**, 59, abst. C. A. 1919, **13**, 4161.
10. U. S. P. 1204608, 1916, abst. J. S. C. I. 1916, **35**, 1271.
11. E. P. 780, 1915; abst. J. S. C. I. 1915, **34**, 1225.
12. U. S. P. 1315542, 1315545, 1315547, 1919, abst. J. S. C. I. 1919, **38**, 847-A, 848-A, C. A. 1919, **13**, 2883, E. P. 136489, 1920.
13. Proc. Roy. Soc. **82B**, 217.
14. U. S. P. 972952, 1910, E. P. 22309, 1910.
15. An. Soc. Quim. Argentina, 1914, **2**, 217, abst. J. C. S. 1915, **108**, i, 114, J. S. C. I. 1915, **34**, 574.
16. E. P. 12406, 1910.
17. D. R. P. 222450, 1908, abst. J. S. C. I. 1910, **29**, 811, Zts. ang. Chem. 1910, **23**, 1389, Chem. Zentr. 1910, **81**, I, 48, Wag. Jahr. 1910, **56**, II, 434, Chem. Zts. 1910, **9**, 1902, C. A. 1910, **4**, 2875, U. S. P. 734123, 1903; abst. J. S. C. I. 1903, **22**, 961, Mon. Sci. 1903, **60**, [(4)], **17**, 173. U. S. P. 790565, 1905; abst. J. S. C. I. 1905, **24**, 686. D. R. P. 153350, 1901; abst. Zts. ang. Chem. 1904, **17**, 1697, Chem. Zentr. 1904, **75**, II, 625; Jahr. Chem. 1904, **76**, 1168; J. C. S. 1904, **86**, i, 853, Chem. Ind. 1904, **27**, 538. D. R. P. 159524, 1901, abst. Chem. Zentr. 1905, **76**, II, 527, Zts. ang. Chem. 1905, **18**, 1626; Jahr. Chem. 1905-1908, II, 98-P, J. C. S. 1906, **90**, i, 6, Chem. Ind. 1905, **28**, 535. E. P. 21628, 1901; abst. J. S. C. I. 1902, **21**, 870. F. P. 317007, 1901, abst. J. S. C. I. 1902, **21**, 870, Mon. Sci. **60**, [(4)], **17**, 54. Aust. P. 31391. It. P. 62042, 1901. E. P. 7341, 1903, abst. J. S. C. I. 1904, **23**, 501. F. P. 330714, 1903, abst. J. S. C. I. 1903, **22**, 1100; Mon. Sci. 1904, (4), **60**, 66. U. S. P. 627031, 1899. E. P. 18283, 1898; abst. J. S. C. I. 1899, **18**, 756. Can. P. 62188, 1899. F. P. 282320, 1899. Russ. P. 3378, 1900. Dan. P. 2636, 1899. Luxem. P. 3302, 3361, 7610, 1899. Port. P. 2899, 1899. Belg. P. 138462, 1898. Add. to Belg. P. 137577. Hung. P. dated Aug. 31 and Nov. 8, 1898. Norw. P. 7610, 1898.

processes for the preparation of esters soluble in 70%,¹ 75%,² or absolute alcohol^{3*} have been published. The alcohol-soluble esters are of low tensile strength. Alcohol-soluble hydrocellulose acetates are known.⁴ Alcohol in combination with toluene,⁵ or dichloroethylene,⁶ or pentachloroethane,⁷ or methyl alcohol,⁸

1. U. S. P. 809935, 1906, abst. J. S. C. I. 1906, **25**, 195, Mon. Sci. 1906, (4), **64**, 120. D. R. P. 185837, 1902, Add. to D. R. P. 159524, abst. Chem. Ind. 1907, **30**, 313, Chem. Tech. Rep. 1907, **31**, 302, Zts. ang. Chem. 1908, **21**, 269, Chem. Zentr. 1907, **78**, II, 654, Jahr. Chem. 1905-1908, 984. First Add. 1425 dated Jan. 30, 1903, to F. P. 317007, abst. J. S. C. I. 1903, **22**, 1015. E. P. 7346, 1903, abst. J. S. C. I. 1901, **23**, 337. Aust. P. 32637, 2. F. P. 432046, 1911, abst. J. S. C. I. 1912, **31**, 21. E. P. 20978, 1911; 20852, 21376, 1912, abst. J. S. C. I. 1913, **32**, 133. Belg. P. 211250, 246250, 246251, 1912. Aust. P. 120, Mar. 10, 1910, Mar. 9, 1911.

3. U. S. P. 734123, 1903, abst. J. S. C. I. 1903, **22**, 961, Mon. Sci. 1903, **60**, [4], **17**, 173. D. R. P. 153350, 1901, abst. Zts. ang. Chem. 1901, **17**, 1697, Chem. Zentr. 1904, **75**, II, 625, Jahr. Chem. 1904, **57**, 1168, J. C. S. 1904, **86**, i, 853, Chem. Ind. 1904, **27**, 538. D. R. P. 159524, 1901, abst. Chem. Zentr. 1905, **76**, II, 527, Zts. ang. Chem. 1905, **18**, 1636, Jahr. Chem. 1905-1908, II, 984, J. C. S. 1906, **90**, i, 6; Chem. Ind. 1905, **28**, 535. U. S. P. 790565, 1905, abst. J. S. C. I. 1905, **24**, 686. E. P. 21628, 1901, abst. J. S. C. I. 1902, **21**, 870. F. P. 317007, 1901, abst. J. S. C. I. 1902, **21**, 870, Mon. Sci. 1903, **60**, [4], **17**, 51. Aust. P. 31391. It. P. 62042, D. R. P. 222450, 1908, abst. J. S. C. I. 1910, **29**, 811, Zts. ang. Chem. 1910, **23**, 1389, Wag. Jahr. 1910, **56**, II, 431, Chem. Zentr. 1910, **61**, I, 48, Chem. Zts. 1910, **9**, 1902. C. A. 1910, **4**, 2875. E. P. 19735, 1908, abst. J. S. C. I. 1910, **29**, 18. F. P. 303963, 1908, abst. J. S. C. I. 1911, **30**, 1232, Zts. ang. Chem. 1908, D. R. P. 237151, 1908, abst. J. S. C. I. 1911, **30**, 1232, Zts. ang. Chem. 1911, **24**, 1838, Chem. Zentr. 1911, **82**, II, 500. The Internationale Celluloseester Ges. (D. R. P. 242289, 1910, abst. Zts. ang. Chem. 1912, **25**, 286, Chem. Zentr. 1912, **83**, I, 298, Chem. Tech. Rep. 1912, **36**, 47, Wag. Jahr. 1912, **58**, II, 17, Chem. Zts. 1912, **11**, No. 2798, C. A. 1912, **6**, 2170), separate cellulose esters from solutions, especially from crude esterifying mixtures, by means of ethyl alcohol as a precipitant. See also D. R. Ann. I-14379 of 1912, and the Internationale Celluloseester Ges., and E. Brommert, D. R. P. Ann. B-17109, 1913, abst. Kunst. 1913, **3**, 100.

4. M. Althausse, U. S. P. 679204, 1901, abst. Mon. Sci. 1901, (4), **57**, 284. F. P. 304723, 1900, abst. J. S. C. I. 1901, **20**, 469, Chem. Zts. 1901, **25**, 270, Mon. Sci. 1900, (4), **59**, 20. D. R. P. 123121, 1900, abst. J. S. C. I. 1901, **20**, 1133, Zts. ang. Chem. 1901, **14**, 905, Chem. Zentr. 1901, **72**, II, 567; Mon. Sci. 1900, (4), **59**, 9, Jahr. Chem. 1901, **54**, 802. E. P. 19039, 1900, abst. J. S. C. I. 1901, **20**, 926. U. S. P. 692497, 1902, abst. J. S. C. I. 1902, **21**, 362, Mon. Sci. 1902, (4), **58**, 161. F. P. 308500, 1901, abst. J. S. C. I. 1902, **21**, 64, Mon. Sci. 1902, (4), **58**, 159.

5. U. S. P. 1015155, 1912, abst. C. A. 1912, **6**, 684, Mon. Sci. 1912, **77**, 163. Swiss P. 52437, abst. Kunst. 1912, **2**, 135. It. P. 47889.

6. U. S. P. 1015156, 1912, abst. Mon. Sci. 1912, **77**, 173. E. P. 1441, 1910; abst. J. S. C. I. 1910, **29**, 1005, Chem. Tech. Rep. 1911, **35**, 340. E. P. 18076, 1910, being First Add. to E. P. 1441, 1910, abst. J. S. C. I. 1910, **29**, 1199. F. P. 412797, 1910, abst. Rev. Chim. Ind. 1910, **21**, 257, J. S. C. I. 1910, **29**, 1199. First Add. 12388, Mar. 19, 1910, to F. P. 412797, abst. J. S. C. I. 1910, **29**, 1199. D. R. P. 238348, 1909, abst. C. A. 1912, **6**, 1672, Chem. Zentr. 1911, **82**, II, 1085, Chem. Ind. 1911, **34**, 637, Chem. Tech. Rep. 1911, **35**, 520. Aust. P. 47889; Swiss P. 52115, abst. Kunst. 1912, **2**, 99. Can. P. 129265, 1910. U. S. P. 888965, 1911, abst. J. S. C. I. 1911, **30**,

or monoacetyllethylaniline,¹ have been advocated for obtaining special results.

Methyl alcohol dissolves some cellulose acetate modifications,² especially in conjunction with tetrachlorethane.³ With amyl alcohol⁴ it forms a useful diluent. Benzyl alcohol,⁵ chlorobenzyl alcohol,⁶ *o*- and *p*-hydroxybenzyl alcohol,⁷ resorcinol,⁸ glycerol,⁹ and chloral alcoholate.¹⁰ Of the carbocyclic alcohols,

616; C. A. 1911, **5**, 2176; Mon. Sci. 1912, **77**, 30. E. P. 16932, 1910; abst. J. S. C. I. 1910, **29**, 1299; Chem. Tech. Rep. 1911, **35**, 35. F. P. 418309, 1910; abst. J. S. C. I. 1911, **30**, 80. Aust. P. 5592, July 11, 1910.

7. E. P. 14364, 1910; abst. J. S. C. I. 1910, **29**, 4152. D. R. P. Anm. F. 20111, of Aug. 25, 1909; refused Feb. 20, 1911. Aust. P. 46991, 1910. Swiss P. 52438; abst. Kunst. 1912, **2**, 135. C. P. 417250, 1910; abst. J. S. C. I. 1911, **30**, 19.

8. W. Lindsay, U. S. P. 1128468, 1133385, 1136248, 1143979, 1226339, 1226340; abst. C. A. 1915, **9**, 1114, 1282, 2311; 1917, **11**, 2153; J. S. C. I. 1915, **34**, 830; 1917, **36**, 707.

1. F. P. 427804, 1910; abst. J. S. C. I. 1911, **30**, 1051; C. A. 1912, **6**, 2315; Chem. Tech. Rep. 1912, **36**, 111.

2. E. P. 26657, 1909; abst. J. S. C. I. 1910, **29**, 1152. F. P. 421010, 1910; abst. J. S. C. I. 1911, **30**, 416.

3. E. P. 10243, 1903; abst. J. S. C. I. 1904, **23**, 557. F. P. 385179, 1907; abst. J. S. C. I. 1908, **27**, 589; C. A. 1909, **3**, 2383; Mon. Sci. 1909, (4), **70**, 105; Bull. Soc. Chim. 1909, (4), **6**, 557. F. P. 385180, 1907; abst. J. S. C. I. 1908, **27**, 589; C. A. 1909, **3**, 2383; Mon. Sci. 1909, (4), **70**, 106; Bull. Soc. Chim. 1909, (4), **6**, 557.

4. U. S. P. 774713, 1904; abst. J. S. C. I. 1904, **23**, 1159; Mon. Sci. 1905, (4), **62**, 50. U. S. P. 774714, 1904; abst. J. S. C. I. 1904, **23**, 1159.

5. H. Dreyfus, U. S. P. 1181859, 1181860, 1916; E. P. 128215, 1919; Swiss P. 63585, 65051, 1911; abst. C. A. 1916, **10**, 1789; 1919, **13**, 2444. J. du Pont, U. S. P. 1317276, 1919; abst. C. A. 1919, **13**, 3316. J. Kessler, U. S. P. 1303563, 1919; abst. J. S. C. I. 1919, **38**, 531-A. A. Labbe, F. P. 468879, 1915; abst. C. A. 1915, **9**, 2297.

6. F. P. 432264, 1911; abst. J. S. C. I. 1912, **31**, 24; Kunst. 1912, **2**, 77. First Add. dated Nov. 19, 1912, to F. P. 432264; abst. J. S. C. I. 1913, **32**, 652. Belg. P. 241251, 1911.

7. J. du Pont, U. S. P. 1317276, 1919; abst. J. S. C. I. 1920, **39**, 103-A.

8. U. S. P. 1005454, 1911; abst. J. S. C. I. 1911, **30**, 1249; E. P. 476, 1910; abst. J. S. C. I. 1910, **29**, 1082. F. P. 411298, 1910; abst. J. S. C. I. 1910, **29**, 978; Phot. Ind. 1910, 1221; Eders Jahr. 1911, 526. Aust. P. 50656, 1910; abst. Kunst. 1912, **2**, 77. Phot. Ind. 1911, 28; Eders Jahr. 1911, 526. Belg. P. 222100, 1910. Hung. Anm. M.-3691, Dec. 30, 1909. Swiss P. 51839, 1910; abst. Kunst. 1912, **2**, 77.

9. C. Claessen, D. R. P. 222450, 1908; abst. J. S. C. I. 1910, **29**, 811; Zts. ang. Chem. 1910, **23**, 1389; Wag. Jahr. 1910, **56**, II, 434; Chem. Zentr. 1910, **81**, 48; Chem. Zts. 1910, **9**, 1902; C. A. 1910, **4**, 2875. F. P. 354942, 1905; abst. J. S. C. I. 1905, **24**, 169. Add. dated June 8, 1905, to F. P. 354942; abst. J. S. C. I. 1905, **24**, 1226. E. P. 12277, 12278, 1905; abst. J. S. C. I. 1906, **25**, 327. D. R. P. 185240, 1906; abst. Zts. ang. Chem. 1907, **30**, 2177; Chem. Zentr. 1907, **78**, II, 1037. D. R. P. 185241, 1906. Add. to D. R. P. 185240; abst. Chem. Zentr. 1907, **78**, II, 1819. E. P. 26657, 1909; abst. J. S. C. I. 1910, **29**, 1152. F. P. 421010, 1910; abst. J. S. C. I. 1911, **30**, 416.

10. E. P. 26657, 1909; abst. J. S. C. I. 1910, **29**, 1152. F. P. 421010, 1910; abst. J. S. C. I. 1911, **30**, 416.

phenol,¹ alone or with trichlorethylene,² or phenol with casein³ or albumen⁴ have been advocated. The cresols⁵ deport themselves similar to phenol. Amidophenol⁶ and thymol⁷ have a low plastifying effect. The naphthols along⁸, or with casein⁹ dissolve acetated cellulose. Cyclopentanol,¹⁰ cyclohexanol,¹¹ cyclo-

1. E. P. 10243, 1903; abst J S C I 1904, **23**, 537. F. P. 385179, 1907; abst. J. S. C. I. 1908, **27**, 589. C. A. 1909, **3**, 2383. Mon. Sci. 1909, (4), **70**, 105; Bull. Soc. Chim. 1909, (4), **6**, 557. F. P. 385180, 1907; abst. J. S. C. I. 1908, **27**, 589. C. A. 1909, **3**, 2383. Mon. Sci. 1909, (4), **70**, 106. Bull. Soc. Chim. 1909, (4), **6**, 557. U. S. P. 774713, 1904; abst. J. S. C. I. 1904, **23**, 1159; Mon. Sci. 1905, (4), **62**, 50. U. S. P. 774711, 1904; abst. J. S. C. I. 1904, **23**, 1159.
2. E. P. 4744, 1911; abst. J. S. C. I. 1912, **31**, 328. C. A. 1912, **6**, 2315. F. P. 440133, 1912; abst. J. S. C. I. 1912, **31**, 480. Kunst. 1912, **2**, 355, 359. U. S. P. 1079773, 1913; abst. J. S. C. I. 1913, **32**, 1153.
3. F. P. 441146, 1911; abst. J. S. C. I. 1912, **31**, 845. Kunst. 1912, **2**, 355. F. P. 354942, 1905; abst. J. S. C. I. 1905, **24**, 1169. Add. dated June 8, 1905, to F. P. 354942; abst. J. S. C. I. 1905, **24**, 1226. E. P. 12277, 1905; abst. J. S. C. I. 1906, **25**, 327. D. R. P. 185240, 1906; abst. Chem. Tech. Rep. 1907, **31**, 361. Wag. Jahr. 1907, **53**, II, 563. Zts. ang. Chem. **1907**, **20**, 2177; Chem. Zentr. 1907, **78**, II, 1037. D. R. P. 185241, 1906. Add. to D. R. P. 185240; abst. Chem. Zentr. 1907, **78**, II, 1819. Chem. Tech. Rep. 1907, **31**, 396. Wag. Jahr. 1907, **53**, II, 563.
4. U. S. P. 952724, 1910; abst. J. S. C. I. 1910, **29**, 563. E. P. 4145, 1909; abst. J. S. C. I. 1910, **29**, 100. F. P. 402028, 1909; abst. J. S. C. I. 1909, **28**, 1212. D. R. P. 242467, 1909; abst. Kunst. 1912, **2**, 59. C. A. 1912, **6**, 2315; Chem. Tech. Rep. 1912, **36**, 111.
5. F. P. 432264, 1911; abst. J. S. C. I. 1912, **31**, 24. Kunst. 1912, **2**, 77. Add. dated Nov. 19, 1912, to F. P. 432264; abst. J. S. C. I. 1913, **32**, 652. Belg. P. 241251, 1911. U. S. P. 774713, 1904; abst. J. S. C. I. 1904, **23**, 1159; Mon. Sci. 1905, **62**, 50. U. S. P. 774711, 1904; abst. J. S. C. I. 1904, **23**, 1159.
6. L. Lederer, U. S. P. 774677, 1904; abst. J. S. C. I. 1904, **23**, 1159. E. P. 7088, 1902; abst. J. S. C. I. 1903, **22**, 563. F. P. 319724, 1902; abst. J. S. C. I. 1902, **21**, 1550. Mon. Sci. 1903, (4), **60**, 123. Add. 811 dated Mar. 18, 1902, to F. P. 319724; abst. J. S. C. I. 1903, **22**, 563. D. R. P. 145106, 1902; abst. Jahr. Chem. 1904, **57**, 1168. Mon. Sci. 1904, (4), **60**, 145106, 1902; abst. Jahr. Chem. 1903, **16**, 1090; Chem. Zentr. 1903, **74**, II, 1155. Wag. Jahr. 1904, **50**, II, 512. D. R. P. 151918, 1902. Add. to D. R. P. 145106, 1902; abst. Chem. Zentr. 1904, **75**, II, 1180. Jahr. Chem. 1904, **57**, 1168. D. R. P. 152111, 1902.
7. U. S. P. 712200, 1902; abst. Mon. Sci. 1903, (4), **60**, 165. C. A. 1912, **6**, 27258, 1910; abst. J. S. C. I. 1911, **30**, 1112. C. A. 1912, **6**, 1526. F. P. 419530, 1910; abst. J. S. C. I. 1911, **30**, 205. First Add. 13237, dated Sept. 29, 1911, to F. P. 419530; abst. J. S. C. I. 1911, **30**, 415. D. R. P. 145106. Can. P. 129983.
8. F. P. 354942, 1905; abst. J. S. C. I. 1905, **24**, 1169. Add. dated June 8, 1905, to F. P. 354942; abst. J. S. C. I. 1905, **24**, 1226. E. P. 12277, 1905; abst. J. S. C. I. 1906, **25**, 327. D. R. P. 185240, 1906; abst. Zts. ang. Chem. 1907, **20**, 2177; Chem. Zentr. 1907, **78**, 1037. D. R. P. 185241, 1906. Add. to D. R. P. 185240; abst. Chem. Zentr. 1907, **78**, II, 1819. F. P. 440733, 1912; abst. J. S. C. I. 1912, **31**, 828; Kunst. 1912, **2**, 414; 1913, **3**, 17. E. P. 3869, 7292, 1912; abst. J. S. C. I. 1912, **31**, 1176. D. R. P. 251351, 1911; abst. C. A. 1913, **7**, 351, 427, 1426; Chem. Tech. Rep. 1912, **36**, 584; Chem. Ind. 1912, **35**, 657; Zts. ang. Chem. 1912, **25**, 2508; Chem. Zentr. 1912, **83**, II, 1246; Farben Ztg. 1912, **17**, 2815; J. S. C. I. 1912,

hexanone,¹ methyl- and dimethyl-cyclohexanone,² cyclohexanone with benzene,³ naphthalene,⁴ benzhydrol,⁵ saligenin,⁶ especially with acetone and alcohol, form useful combinations.

The ethers, as a class, are poor solvents, especially those of lower molecular weight. Diethyl ether⁷ has been pointed out as an acceptable esterizing diluent,⁸ but its boiling point is too low. Methylphenyl and ethylphenyl ethers and naphthyl ether have been patented as plasticity inducing bodies.⁹ Diphenyl

31, 1191. D. R. P. 255692, 1912, abst. C. A. 1913, **7**, 1815, Kunst. 1913, **3**, 20. U. S. P. 1045895, 1912, abst. J. S. C. I. 1913, **32**, 19.

11. F. Raschig, U. S. P. 900204, 1908. D. R. P. 174914, 1905, Chem. Centr. 1906, **77**, II, 1702, Jahr. Chem. 1905-1908, II, 993; Zts. ang. Chem. 1907, **20**, 369; Chem. Zts. 1907, **6**, 9, Wag. Jahr. 1906, **52**, II, 527.

1. Cellon, Ltd., and T. Tyrer, E. P. 150402; U. S. P. 1339728, 1920.

2. H. Dreyfus, E. P. 128215, 1920.

3. Badische Anilin u. Soda Fabrik, E. P. 14042, 1914; D. R. P. 284672, 1914; abst. J. S. C. I. 1915, **34**, 956, 1948.

4. J. Jarvis, U. S. P. 1343135, 1920.

5. F. P. 432264, 1911, abst. J. S. C. I. 1912, **31**, 24; Kunst. 1912, **2**, 77. First Add. dated Nov. 19, 1912, to F. P. 432264, 1911; abst. J. S. C. I. 1913, **32**, 652. Belg. P. 241251, 1911.

6. E. P. 27258, 1910, abst. J. S. C. I. 1911, **30**, 1112, C. A. 1912, **6**, 1526. F. P. 419530, 1910, abst. J. S. C. I. 1911, **30**, 205. First Add. 13237, dated Sept. 29, 1911, to F. P. 419530, abst. J. S. C. I. 1911, **30**, 415. D. R. P. 145106. Can. P. 129983.

7. D. R. P. 222450, 1908, abst. J. S. C. I. 1910, **29**, 811, Zts. ang. Chem. 1910, **23**, 1389, Wag. Jahr. 1910, **56**, II, 434, Chem. Zentr. 1910, **81**, I, 48, Chem. Zts. 1910, **9**, 1902, C. A. 1910, **4**, 2875. U. S. P. 734123, 1903, abst. J. S. C. I. 1903, **22**, 961, Mon. Sci. 1903, **60**, [(4), **17**], 173. U. S. P. 790565, 1905; abst. J. S. C. I. 1905, **24**, 686. E. P. 21628, 1901, abst. J. S. C. I. 1902, **21**, 870, F. P. 317007, 1901, abst. J. S. C. I. 1902, **21**, 870, Mon. Sci. 1903, **60**, [(4), **17**], 54. D. R. P. 153350, 1901, abst. Zts. ang. Chem. 1904, **17**, 1697, Chem. Centr. 1904, **50**, II, 625, Jahr. Chem. 1904, **57**, 1168, J. C. S. 1904, **86**, i, 853, Chem. Ind. 1904, **27**, 538. D. R. P. 159524, 1901; abst. Chem. Centr. 1905, **76**, II, 527, Zts. ang. Chem. 1905, **18**, 1636, Jahr. Chem. 1905-1908, II, 984; J. C. S. 1906, **90**, i, 6, Chem. Ind. 1905, **28**, 535. Aust. P. 31391. It. P. 62042, 1901.

8. U. S. P. 812098, 1906; abst. J. S. C. I. 1906, **25**, 232, Mon. Sci. 1906, (4), **64**, 120. E. P. 24083, 1904, abst. J. S. C. I. 1905, **24**, 1081, F. P. 347906, 1904, abst. J. S. C. I. 1905, **24**, 454, Mon. Sci. 1906, (4), **64**, 15, Chem. Ztg. 1905, **29**, 493. D. R. P. 184145, 1904; abst. Chem. Zentr. 1907, **78**, 365; Mon. Sci. 1909, **70**, 77, Jahr. Chem. 1905-1908, 983, Zts. ang. Chem. 1908, **21**, 268; Chem. Ind. 1907, **30**, 238. D. R. P. 184201, 1904, abst. Zts. ang. Chem. 1908, **21**, 268; Chem. Zentr. 1907, **78**, 365; Mon. Sci. 1909, **70**, 77; Jahr. Chem. 1905-1908, 984, Zts. ang. Chem. 1908, **21**, 268; Chem. Ind. 1907, **30**, 238. Swed. P. 20249, 1905. Russ. P. 11492, 1907. D. R. P. 237151, 1908; abst. J. S. C. I. 1911, **30**, 1232; Zts. ang. Chem. 1911, **24**, 1838, Chem. Zentr. 1911, **82**, II, 500. D. R. P. 242289, 1910, abst. C. A. 1912, **6**, 2170; Kunst. 1913, **3**, 35, Chem. Zts. 1912, **11**, 2798; Chem. Tech. Rep. 1912, **36**, 47; Zts. ang. Chem. 1912, **25**, 286; Chem. Ind. 1912, **35**, 87, Chem. Zentr. 1912, **83**, I, 298.

9. H. Dreyfus, E. P. 1181859, 1181860, 1916, abst. C. A. 1916, **10**, 1789. F. P. 432264, 1911; abst. J. S. C. I. 1912, **31**, 24, Kunst. 1912, **2**, 77. First Add. dated Nov. 19, 1912, to F. P. 432264, 1911; abst. J. S. C. I. 1913, **32**, 652. Belg. P. 241251, 1911.

ether,¹ pyrocatechin diethyl ether and guaiacol are too expensive. Furfurol² and furfural³ have recently been brought forward.

The aldehydes, as a class, are of relatively minor importance. Formaldehyde with shellac,⁴ acetaldehyde,⁵ acetaldol,⁶ chloral hydrate,⁷ and alcoholate,⁸ and chloral with phenol,⁹ or tetrachlorethane¹⁰ or amyl lactate¹¹ have been proposed.

As a cellulose acetate solvent, acetone has been widely used,¹² either alone or in combination with acetylene tetrachloride,¹³

1. E. P. 8945, 1909, abst. J. S. C. I. 1909, **28**, 1271. F. P. 402083, 1909, abst. J. S. C. I. 1909, **28**, 1276. Mon. Sci. 1910, (4), **73**, 168.
2. G. Bonwitt, E. P. 138078, 1920, abst. C. A. 1920, **14**, 1762.
3. F. Stemming, D. R. P. 307075, 1917. J. S. C. I. 1920, **39**, 163-A.
4. U. S. P. 952724, 1910, abst. J. S. C. I. 1910, **29**, 503. E. P. 4154, 1909, abst. J. S. C. I. 1910, **29**, 100. F. P. 402028, 1909, abst. J. S. C. I. 1909, **28**, 1212. D. R. P. 242467, 1908, abst. Kunst. 1912, **2**, 59. C. A. 1912, **6**, 2315, Chem. Tech. Rep. 1912, **36**, 111.
5. R. Gilmour and W. Dunville & Co., E. P. 131647, 1918, abst. C. A. 1920, **14**, 316. J. S. C. I. 1919, **38**, 896-A.
6. J. Kessler, U. S. P. 1303563, abst. 1919, **13**, 1938.
7. E. P. 26657, 1909, abst. J. S. C. I. 1910, **29**, 1152. F. P. 421010, 1910, abst. J. S. C. I. 1911, **30**, 416.
8. E. P. 9537, 1907, abst. J. S. C. I. 1908, **27**, 589. F. P. 377010, 1907, abst. J. S. C. I. 1907, **26**, 1027. Mon. Sci. 1908, (4), **68**, 444. D. R. P. 189703, 1902, abst. Chem. Zts. 1907, **6**, 387. Chem. Zentr. 1907, **78**, II, 1822. Chem. Tech. Rep. 1907, **31**, 570. Wag. Jahr. 1907, **53**, II, 562. Mon. Sci. 1910, (4), **73**, 159. D. R. P. 152111, 1902, abst. Zts. ang. Chem. 1904, **17**, 1250. Chem. Centr. 1904, **75**, II, 382. Mon. Sci. 1910, (4), **73**, 159. Jahr. Chem. 1904, **57**, 1168. D. R. P. 220228, 1907, abst. Chem. Zts. 1910, **9**, 1934. Chem. Ind. 1910, **33**, 271. Chem. Tech. Rep. 1910, **34**, 180. Wag. Jahr. 1910, **56**, II, 589. Aust. P. 34008, 1908, Zts. ang. Chem. 1909, **22**, 505.
9. Lederer, U. S. P. 1195010, 1916, F. P. 377010, 1907. Aust. P. 16377, 1904, abst. J. S. C. I. 1907, **26**, 1027, 1916, **35**, 961.
10. E. P. 27258, 1910, abst. J. S. C. I. 1911, **30**, 1112. F. P. 419530, 1910, abst. J. S. C. I. 1911, **30**, 205.
11. First Add. 13237, dated Sept. 29, 1911, to F. P. 419530, abst. J. S. C. I. 1911, **30**, 115.
12. U. S. P. 909490, 1911, abst. J. S. C. I. 1911, **30**, 1051.
13. E. P. 24067, 1906, abst. J. S. C. I. 1907, **26**, 1213. F. P. 371447, 1906, abst. J. S. C. I. 1907, **26**, 310. Mon. Sci. 1908, **68**, 79. Chem. Tech. Rep. 1907, **31**, 149. U. S. P. 838350, 1906, abst. J. S. C. I. 1907, **26**, 165. Mon. Sci. 1907, **66**, 1161. Ressue 12637 thereon, date April 23, 1907, abst. J. S. C. I. 1907, **26**, 634. Mon. Sci. 1907, **66**, 159. E. P. 16330, 1905, Vaid, abst. J. S. C. I. 1906, **25**, 805. F. P. 358079, 1905, abst. Mon. Sci. 1906, **64**, 169. J. S. C. I. 1906, **25**, 195. Hung. P. 35806, 1905. Belg. P. 187308, 1905. Aust. P. 41461, 1909. Can. P. 103045. It. P. No. 97, Vol. 215, 1905. D. R. P. Ann. M-28289, 1905. F. P. 427265, 1911, abst. J. S. C. I. 1911, **30**, 1051. Chem. Tech. Rep. 1911, **35**, 481. Hung. Appl. O-674, 1912. Aust. P. 296, A-1787, 1912, abst. Kunst. 1912, **2**, 460. U. S. P. 734123, 1903, abst. J. S. C. I. 1903, **22**, 961. Mon. Sci. 1903, **60**, 173. U. S. P. 790565, 1905, abst. J. S. C. I. 1905, **24**, 686. D. R. P. 153350, 1901, abst. Zts. ang. Chem. 1904, **17**, 1697. Chem. Centr. 1904, **75**, II, 625. Jahr. Chem. 1904, **57**, 1168. J. C. S. 1904, **86**, i, 853. Chem. Ind. 1904, **27**, 538. D. R. P. 159524, 1901, abst. Chem. Centr. 1905, **76**, II, 527. Zts. ang. Chem.

camphor,¹ pentachlorethane,² or chlorinated stearic acid.³ Dichloroacetone,⁴ benzylidihydrocarvone,⁵ naphthyl-magnesium halogen compounds, and acetylacetone and ethylideneacetone⁶ have been patented as cellulose acetate plastifiers and direct solvents. Acetophenone makes a useful solvent⁷ and softener.⁸

- 1905, **11**, 1636; *Jahrb. Chem.* 1908-1908, II, 984; J. S. C. I. 1906, **90**, i, 6; *Chem. Ind.* 1905, **25**, 535. E. P. 21628, 1901; abst. J. S. C. I. 1902, **21**, 870. F. P. 317007, 1901; abst. J. S. C. I. 1902, **21**, 870; *Mon. Sci.* 1903, (4), **60**, 54. Aust. P. 31391. It. P. 62042, 1901. U. S. P. 987692, 1911; abst. J. S. C. I. 1911, **30**, 485; *Chem. Tech. Rep.* 1911, **35**, 250. E. P. 14271, 1910; abst. J. S. C. I. 1911, **30**, 485. F. P. 417274, 1910; abst. J. S. C. I. 1911, **30**, 485. Aust. P. of Aug. 14, 1909, July 21, 1910. D. R. P. 222450, 1908; abst. J. S. C. I. 1910, **29**, 811; *Zts. ang. Chem.* 1910, **23**, 1389; *Wag. Jahr.* 1910, **56**, II, 434; *Chem. Zentr.* 1910, **81**, I, 48; *Chem. Zts.* 1910, **9**, 1902; C. A. 1910, **4**, 2875. E. P. 4863, 1903; abst. J. S. C. I. 1904, **23**, 382. F. P. 324121, 1902; abst. J. S. C. I. 1904, **23**, 569. F. P. 432046, 1911; abst. J. S. C. I. 1912, **31**, 24. First Add. dated July 7, 1911, to F. P. 432046; abst. J. S. C. I. 1912, **31**, 325. Second Add. to F. P. 432046; abst. J. S. C. I. 1912, **31**, 225. Third Add. 15933, dated Jan. 4, 1912, to F. P. 432046; abst. *Chem. Ztg.* 1912, **34**, 1174. Fourth Add. 15894, dated April 4, 1912; abst. J. S. C. I. 1912, **31**, 1119. Fifth Add. 16316, dated April 1, 1912; abst. J. S. C. I. 1912, **31**, 1119. Sixth Add. dated Aug. 5, 1912, to F. P. 432046; abst. J. S. C. I. 1913, **32**, 283. Seventh Add. dated Sept. 16, 1912, to F. P. 432046; abst. J. S. C. I. 1913, **32**, 420. E. P. 20978, 1911, same as First Add. to F. P. 432046; abst. *Kunst.* 1913, **3**, 195. E. P. 20852, 1912. E. P. 21376, 1912, division of 20978, 1911; abst. J. S. C. I. 1913, **32**, 133. E. P. 20977, 1911, same as F. Appl. July 5, 1911; abst. J. S. C. I. 1913, **32**, 133; C. A. 1913, **7**, 891. Belg. P. 241250, 246250, 246251, 1912. Aust. P. 120, Mar. 16, 1910; Mar. 9, 1911.
13. E. P. 11625, 1909; abst. J. S. C. I. 1909, **28**, 1030. F. P. 402072, 1909; abst. J. S. C. I. 1909, **28**, 1221. D. R. P. 240751, 1908; abst. C. A. 1912, **6**, 2179; *Wag. Jahr.* 1911, **57**, II, 421; *Kunst.* 1912, **2**, 15; *Chem. Ind.* 1911, **34**, 798; *Chem. Ztg.* 1911, **35**, 624; *Zts. ang. Chem.* 1912, **25**, 47; *Chem. Zentr.* 1911, **82**, II, 1843; D. R. P. 248559, 1909; Add. to D. R. P. 240751; abst. *Wag. Jahr.* 1912, **58**, II, 445; *Kunst.* 1912, **2**, 296; *Zts. ang. Chem.* 1912, **25**, 1884; C. A. 1912, **6**, 2849; *Chem. Tech. Rep.* 1912, **36**, 437; *Zts. ang. Chem.* 1912, **25**, 1884; *Chem. Zentr.* 1912, **83**, II, 305.
1. E. P. 19735, 1908; abst. J. S. C. I. 1910, **29**, 18; F. P. 393963, 1908; abst. J. S. C. I. 1909, **28**, 257. D. R. P. 223793, 1907, being Add. to D. R. P. 210519; *Mon. Sci.* 1913, **78**, 38; *Wag. Jahr.* 1909, **55**, II, 555; 1910, II, 483. Aust. P. 51094, 1908.
2. E. P. 14364, 1910; abst. J. S. C. I. 1910, **29**, 1152. D. R. P. Anm. F. 28111 of Aug. 25, 1909; refused Feb. 20, 1911. Aust. P. 46991, 1910; Swiss P. 52438; abst. *Kunst.* 1912, **2**, 135. F. P. 417250, 1910; abst. J. S. C. I. 1911, **30**, 19.
2. U. S. P. 855556, 1907.
4. F. P. 432264, 1911; abst. J. S. C. I. 1912, **31**, 24; *Kunst.* 1912, **2**, 77. First Add. dated Nov. 19, 1912, to F. P. 432264; abst. J. S. C. I. 1913, **31**, 652. Belg. P. 241251.
5. D. R. P. 202720, 1907; abst. J. S. C. I. 1908, **27**, 1220; *Zts. ang. Chem.* 1908, **21**, 2428; *Chem. Zentr.* 1908, **79**, II, 1837; *Jahrb. Chem.* 1905-1908, II, 993; *Mon. Sci.* 1912, **77**, 57.
6. H. Dreyfus, R. P. 131669, 1918; abst. C. A. 1920, **14**, 346.
7. U. S. P. 1005454, 1911; abst. J. S. C. I. 1911, **30**, 1249. E. P. 476, 1910; abst. J. S. C. I. 1910, **29**, 1082. F. P. 411298, 1910; abst. J. S. C. I. 1910, **29**, 978; *Phot. Ind.* 1910, 1221; *Eders Jahr.* 1911, 526. Aust. P.

Methyl acetone¹ has been used in acetate dopes. Acetone in combination with dihydroxydiphenyldimethylmethane² and cellulose forms the cellulose acetate plastic of W. Beatty. This is similar to the cumarone and indene plastic of F. Lehmann and J. Stocker.³

The simplest organic acid-formic is a solvent of certain cellulose acetates, as has been claimed by J. Bernberg⁴ and A. Schloss.⁵ Lactic acid in the hands of C. Waite,⁶ Veremigte Glanzstoff Fabriken⁷ and A. Schloss,⁸ has proven a valuable direct solvent, but it is hygroscopic and soluble in water. Oleic acid,⁹ sulfonated fatty acids¹⁰ and chlorinated stearic acid¹¹ induce

50656, 1910; abst. Kunst 1912, **2**, 77; Phot. Ind. 1911, 28; Eders. Jahr. 1911, 526. Belg. P. 222106, 1910. Hung. Ann. M. 3691, Dec. 30, 1909. Swiss P. 51839, 1910, abst. Kunst 1912, **2**, 77. G. Ferguson, U. S. P. 1270394, 1270395, 1270396, 1270397, 1918.

8. U. S. P. 774677, 1904, abst. J. S. C. I. 1904, **23**, 1159. E. P. 7088, 1902; abst. J. S. C. I. 1903, **22**, 563. F. P. 319724, 1902, abst. J. S. C. I. 1902, **21**, 1550. Mon. Sci. 1903, (4), **60**, 123. Add. 811 dated Mar. 18, 1902, to F. P. 319724, abst. J. S. C. I. 1903, **22**, 563. D. R. P. 145106, 1902, abst. Jahr. Chem. 1904, **57**, 1168. Mon. Sci. 1904, (4), **60**, 93. Zts. ang. Chem. 1903, **16**, 1090; Chem. Centr. 1903, **74**, II, 1155. D. R. P. 151918, 1902. Add. to D. R. P. 145106, abst. Chem. Centr. 1904, **75**, II, 1180. Jahr. Chem. 1904, 1168. D. R. P. 152111, 1902.

1. U. S. P. 999490, 1911, abst. J. S. C. I. 1911, **30**, 1051.

2. U. S. P. 1158960, 1158961, 1188356, 1916. E. P. 18499, 1913, abst. J. S. C. I. 1914, **38**, 746.

3. U. S. P. 1185514, 1191801, 1916. F. P. 469925, 1911; abst. C. A. 1916, **10**, 1939, 2299. J. S. C. I. 1915, **34**, 25, 1916, **35**, 929.

4. E. P. 2511, 1907, abst. J. S. C. I. 1907, **26**, 634. Jour. Soc. Dyers and Col. 1907, **23**, 215. F. P. 376262, 1907, abst. J. S. C. I. 1907, **26**, 988. Mon. Sci. 1908, (4), **68**, 87. D. R. P. 189836, 189837, 1908, abst. Zts. ang. Chem. 1908, **21**, 268. Jahr. Chem. 1905-1908, II, 983. J. C. S. 1908, **94**, i, 321. Chem. Ind. 1907, **30**, 617.

5. U. S. P. 922340, 1909, abst. J. S. C. I. 1909, **28**, 671. F. P. 400652, 1909; abst. J. S. C. I. 1909, **28**, 1061. D. R. P. 237718, 1907. H. P. 101262, 1909.

6. U. S. P. 690211, 1901, abst. J. S. C. I. 1902, **21**, 272.

7. U. S. P. 1029341, 1912, abst. J. S. C. I. 1912, **31**, 637. Mon. Sci. 1912, **77**, 164. E. P. 8313, 1911, abst. J. S. C. I. 1911, **30**, 1050. Chem. Tech. Rep. 1911, **35**, 556, 1912, **36**, 532. C. A. 1912, **6**, 3018. F. P. 428009, 1911, abst. J. S. C. I. 1911, **30**, 1156. Aust. App. 2994, 1911.

8. U. S. P. 922340, 1909, abst. J. S. C. I. 1909, **28**, 671. E. P. 6554, 1909; abst. J. S. C. I. 1910, **29**, 18. D. R. P. 239701, 1910, abst. Chem. Zentr. 1911, **82**, II, 1502; C. A. 1912, **6**, 2169. Chem. Tech. Rep. 1911, **35**, 556. D. R. P. 237599, 1907, abst. C. A. 1912, **6**, 1679. Zts. ang. Chem. 1911, **24**, 1838; Wag. Jahr. 1911, **57**, II, 419. Chem. Zentr. 1911, **82**, II, 814. Chem. Tech. Rep. 1911, **35**, 481. Belg. P. 214671, 1909. F. P. 400652, 1909; abst. J. S. C. I. 1909, **28**, 1061. Mon. Sci. 1910, (4), **73**, 165. D. R. P. 237718, 1907; abst. Zts. ang. Chem. 1911, **24**, 1988; Chem. Zentr. 1911, **82**, II, 922; Wag. Jahr. 1911, **57**, II, 418; Chem. Ind. 1911, **34**, 573; Chem. Tech. Rep. 1911, **35**, 481.

9. U. S. P. 792149, 1905; abst. J. S. C. I. 1905, **24**, 799; Mon. Sci. 1906,

flexibility, but their solvent power is practically zero. Cresylic acid¹ has recently been patented as a constituent in acetate dope.

The esters have proven among the most valuable of the solvents for acetated cellulose. Ethyl or methyl acetoacetate,² dibutyl oxalate,³ amyl acetate and acetone,⁴ phenyl salicylate,⁵ triphenyl-, tricesyl-, and trinaphthyl phosphates,⁶ alone or with urea⁷ or camphor,⁸ triphenyl borate,⁹ methyl acetate,¹⁰

(4), **64**, 22. U. S. P. 712200, 1902, abst. Mon. Sci. 1903, (4), **60**, 165.

10. E. P. 14142, 1911; abst. J. S. C. I. 1912, **31**, 680, C. A. 1913, **7**, 217. Aust. P. 55527, abst. Kunst. 1913, **3**, 38.

11. U. S. P. 855556, 1907. U. S. P. 953454, 962877, 1910; abst. J. S. C. I. 1910, **29**, 940.

1. A. Zimmer, J. Bryce, and G. Davies, E. P. 124807; abst. C. A. 1919, **13**, 1771, J. S. C. I. 1919, **38**, 379-A.

2. L. Clement and C. Riviere, F. P. 479387, 1916, abst. C. A. 1916, **10**, 2308.

3. H. Clarke, U. S. P. 1309980, 1919, includes diamyl oxalate. P. Seel (U. S. P. 1342601, 1342602, 1920) combines cellulose esters with chlorinated naphthalenes, as α -monochloronaphthalene. P. Seel, U. S. P. 1342603, 1920, covers the use of ethyl propionate as a cellulose acetate solvent.

4. I. Hey, E. P. 15428, 1915, abst. J. S. C. I. 1916, **35**, 960, Zts. ang. Chem. 1916, **29**, II, 506.

5. H. Mork and G. Esselen, U. S. P. 1193178, 1916, abst. C. A. 1916, **10**, 2404, J. S. C. I. 1916, **35**, 961.

6. W. Lindsay, D. R. P. 263056, 1910, Kunst. 1913, **3**, 375. U. S. P. 1045990, 1913, abst. J. S. C. I. 1913, **32**, 19, C. A. 1913, **7**, 699, 1050065, 1913, abst. J. S. C. I. 1913, **32**, 133, Kunst. 1913, **3**, 218. U. S. P. 1067785, 1913, abst. J. S. C. I. 1913, **32**, 823, C. A. 1913, **7**, 3025. E. P. 10794, 1910, abst. J. S. C. I. 1911, **30**, 679. E. P. 10795, 1910, abst. J. S. C. I. 1911, **30**, 205. F. P. 415517, 415518, 1910, abst. J. S. C. I. 1910, **19**, 1299, Mon. Sci. 1912, **77**, 9.

7. W. Lindsay, U. S. P. 1067785, 1913, 1233374, 1917, 1319229, 1919; abst. J. S. C. I. 1913, **32**, 823, C. A. 1913, **7**, 3025. F. P. 415518, 1910, abst. J. S. C. I. 1910, **29**, 1299, Mon. Sci. 1912, **77**, 9. Can. P. 175107.

8. U. S. P. 1041115, 1912, abst. J. S. C. I. 1912, **31**, 1075, C. A. 1912, **6**, 3518, Mon. Sci. 1913, **79**, 110.

9. Farbenfabriken vorm. F. Bayer and Co., U. S. P. 1031616, 1912; J. S. C. I. 1912, **31**, 770, C. A. 1912, **6**, 2687. E. P. 18193, 1909, abst. J. S. C. I. 1910, **29**, 575. E. P. 11354, 1909, abst. J. S. C. I. 1910, **29**, 752. E. P. 13100, 1910, abst. J. S. C. I. 1911, **30**, 533. F. P. 408370, 1910; abst. J. S. C. I. 1910, **29**, 624. First Add. No. 12400, dated April 13, 1910, to F. P. 408370, 1910, abst. J. S. C. I. 1910, **29**, 1299. Second Add. dated June 11, 1910, to F. P. 408370, 1910, abst. J. S. C. I. 1910, **29**, 1371. Aust. P. 29b, 4624, 10, June 21, 1909.

10. A. Wohl, E. P. 12422, 1910, 3139, 1911, abst. J. S. C. I. 1911; **30**, 888, Chem. Tech. Rep. 1911, **35**, 520. F. P. 425900, 1911; abst. Mon. Sci. 1913, **78**, 121, J. S. C. I. 1911, **30**, 951. Belg. P. 232699, 1911. D. R. Ann. W. 36069, 1910; D. R. P. 246651, 1910; abst. C. A. 1912, **6**, 2529, Chem. Tech. Rep. 1912, **36**, 332; Wag. Jahr. 1912, **58**, II, 445; Zts. ang. Chem. 1912, **25**, 1549, Chem. Zentr. 1912, **83**, I, 1742. Aust. 29b, A 403, 1911, Mar. 12, 1910; Jan. 14, 1911. D. R. P. 246657, 1910, abst. Kunst. 1912, **2**, 232. F. P. 435742, 1912; abst. Mon. Sci. 1913, **78**, 133. The Societe anonyme Le Camphre, F. P. 452432, 1912, combine methyl acetate with tetrachlorethane or acetone as an acetate plastic solvent.

and some of the sulfonic acid esters¹ have been employed for selective purposes. Propyl chlorstearate, myristate, palmitate, and stearate² have but weak dissolving power. Phenyl, cresyl and naphthyl esters,³ and mono-,⁴ di-,⁵ and tri-acetin⁶ have been used, especially the latter. The cellulose acetate plastics of F. Meyer,⁷ H. Manissadjian,⁸ H. Darfzer,⁹ and C. Dreyfus,¹⁰ com-

1. D. R. P. 200334, 1907, abst. J. S. C. I. 1908, **27**, 1130, Mon. Sci. 1911, (5), **74**, 63, Chem. Zts. 1908, **7**, 909, Zts. ang. Chem. 1908, **21**, 2233, Chem. Zentr. 1908, **79**, 11, 655, Jahr. Chem. 1905-08, 11, 987, J. C. S. 1908, **94**, i, 955, Chem. Ind. 1908, **31**, 499. For the modifying action of ethyl acetate on acetyl chloride in the presence of cellulose hydrate, see E. P. 11549, 1900, abst. J. S. C. I. 1901, **20**, 741. D. R. P. 163316, 1901, abst. Zts. ang. Chem. 1906, **19**, 204, Chem. Centr. 1905, **76**, 11, 901, Mon. Sci. 1906, (1), **64**, 159, Jahr. Chem. 1905-08, 11, 988, Chem. Ind. 1905, **28**, 659, Wag. Jahr. 1905, **51**, 11, 191. D. R. P. 200916, 1901, being Add. to D. R. P. 163316, abst. Mon. Sci. 1911, (5), **74**, 82, Wag. Jahr. 1908, **54**, 11, 364, Zts. ang. Chem. 1908, **21**, 2047, Chem. Zentr. 1908, **79**, 11, 738, Chem. Ind. 1908, **31**, 559, F. P. 319848, 1902, abst. J. S. C. I. 1902, **21**, 1550, Mon. Sci. 1903, (4), **60**, 123, Aust. 42440, 1909.
2. U. S. P. 962877, 1910, abst. J. S. C. I. 1910, **29**, 940.
3. W. Merckens and H. Manissadjian, Aust. P. 47697, 1910.
4. U. S. P. 1015155, 1912, abst. Mon. Sci. 1912, **77**, 109. Swiss P. 52437, abst. Kunst. 1912, **2**, 135. Aust. P. 47889.
5. U. S. P. 1031616, 1912, abst. J. S. C. I. 1912, **31**, 770, C. A. 1912, **6**, 2687. E. P. 18193, 1909, abst. J. S. C. I. 1910, **29**, 575. E. P. 11354, 1909, abst. J. S. C. I. 1910, **29**, 752. E. P. 13100, 1910, abst. J. S. C. I. 1911, **30**, 533. F. P. 408370, 1910, abst. J. S. C. I. 1910, **29**, 624. First Add. No. 12469, dated April 13, 1910, to F. P. 408370, 1910, abst. J. S. C. I. 1910, **29**, 1299. Second Add. dated June 11, 1910, to F. P. 408370, 1910, abst. J. S. C. I. 1910, **29**, 1371. Aust. P. 164210, June 21, 1909. For preparation of mono-chlorhydrin mono- and diacetates, diacetyl, aceto-chlorhydrin and iodo-hydrin diacetate, see R. Wegscheider and F. Zinnerhikar, Monatsh. 1913, **34**, 1061, abst. C. A. 1913, **7**, 3484. See G. Noyer, "Camphor Substitutes with Acetylcellulose," Caout. et Gutta. 1913, **10**, 6999, abst. Kunst. 1913, **3**, 353.
6. F. P. 432264, 1911, abst. J. S. C. I. 1912, **31**, 24, Kunst. 1912, **2**, 77. First Add. dated Nov. 19, 1912, to F. P. 432264, abst. J. S. C. I. 1913, **32**, 652. Belg. P. 244251, 1911.
7. E. P. 19735, 1908, abst. J. S. C. I. 1910, **29**, 18. F. P. 303963, 1908, abst. J. S. C. I. 1909, **28**, 257. D. R. P. 223793, being Add. to D. R. P. 210519. Aust. 51094, 1908.
8. F. P. 397429, 1908, abst. J. S. C. I. 1909, **28**, 812.
9. F. P. 443031, 1911. U. S. P. 1089910, 1914, Swiss P. 63585, 1911, abst. J. S. C. I. 1912, **31**, 1008, 1914, **33**, 375, C. A. 1914, **8**, 1551, 2252. E. P. 132230, 1912, abst. Kunst. 1913, **3**, 73, C. A. 1913, **7**, 3840. Diphenylglyceryl ether may be obtained from the dichlorhydrins and sodium phenylate, phenylglycide epichlorhydrin and sodium phenolate, chlorinated diphenyl glyceryl ethers from the dichlorhydrins and chlorinate sodium phenolate; and diacetylglyceryl ethers from the dichlorhydrins and sodium cresolates. In this connection see L. Clement and C. Riviere, Kunst. 1912, **2**, 436. See also G. Noyer (Caout. et Gutta. 1914, **10**, 7297, 7362, 1, Ind. Cinem. 1913, **2**, 165, abst. C. A. 1913, **7**, 4068, 1914, **8**, 821), for the formins (glyceryl formates), oxalins (glyceryl oxalates), monoformin, diformin, epiformin, epidiformin, triformin, acetylformins, acetyl-monoformin, acetyl diformin and the nitroformins as camphor substitutes. For the ester-

prise the employment of triacetin. Acetin with tricresyl phosphate,¹ with dichlorhydrin,² and bergamot oil,³ have been specified. Glyceryl benzoate,⁴ salicylate, phthalate or phthalonate have also been advocated. Pathe Freres⁵ prefer methyl acetate with polymers of isoprene in conjunction with cellulose acetate, and the Chemische Fabrik v. Heyden, methyl or ethyl glycerol-chlorhydrin, or methylene or ethylene chlorhydrin.⁶ Phenyl-acetate,⁷ benzyl acetate,⁸ resorcinol diacetate,⁹ methyl chloracetate,¹⁰ ethyl chloracetate,¹¹ methyl formate,¹² glycol benzoate¹³

fication of glycerol by acetic acid in the presence of catalytic agents, see J. Senderens and J. Aboulenc, *Compt. rend.* 1914, **158**, 581, abst. C. A. 1914, **8**, 1752. For the electrolytic production of chlorhydrins see R. Haddan, E. P. 140831, 1917; abst. C. A. 1920, **14**, 2139.

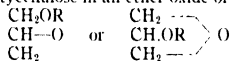
10. E. P. 127615, 127678, 1917, abst. C. A. 1919, **13**, 2444; J. S. C. I. 1919, **38**, 531-A.

1. Compagnie Francaise du Celluloid, F. P. 440955, 1911; abst. Kunst. 1912, **2**, 355, Mon. Sci. 1914, **80**, 14.

2. A. Eichengruen, U. S. P. 1015155, 1912; abst. Mon. Sci. 1912, **77**, 163. Swiss P. 52437; abst. Kunst. 1912, **2**, 135. Aust. P. 47889.

3. M. Salamon and W. Seaber, *Perf. Essent. Oil Record*, **3**, 275; abst. C. A. 1913, **7**, 863.

4. F. P. 461544, 1913, abst. J. S. C. I. 1914, **33**, 196. The Compagnie Gen. de Phon. Cinemat. et Appareils de Precision (Swiss P. 61929, 1912; abst. C. A. 1914, **8**, 2124. U. S. P. 1089910, 1914; abst. Kunst. 1914, **4**, 275), prepare a flexible compound for the manufacture of cinematographic films from a solution of acetylcellulose in an ether oxide of glycerol, as



5. F. P. 475351, 1914; abst. J. S. C. I. 1916, **35**, 73.

6. D. R. P. 288267, 1915; abst. Chem. Zentr. 1915, **86**, II, 1037.

7. R. Riddle, U. S. P. 797373, 1905.

8. U. S. P. 1031616, 1912; abst. J. S. C. I. 1912, **31**, 770; C. A. 1912, **6**, 2687. E. P. 18193, 1909; abst. J. S. C. I. 1910, **29**, 575; E. P. 11354, 1909; abst. J. S. C. I. 1910, **29**, 752. E. P. 13100, 1910, abst. J. S. C. I. 1911, **30**, 233. F. P. 408370, 1910, abst. J. S. C. I. 1910, **29**, 624. First Add. No. 12469, dated April 13, 1910, to F. P. 408370, abst. J. S. C. I. 1910, **29**, 1299. Second Add. dated June 11, 1910, to F. P. 408370, abst. J. S. C. I. 1910, **29**, 1371. Aust. P. 29b, 4642-10, June 21, 1909.

9. L. Lederer, E. P. 8945, 1909; abst. J. S. C. I. 1909, **28**, 1271. F. P. 402083, 1909; abst. J. S. C. I. 1909, **28**, 1270, Mon. Sci. 1910, (4), **73**, 168. Knoll & Co. (D. R. P. 298806; abst. J. S. C. I. 1920, **39**, 483-A) combine resorcinol monoacetate with cellulose acetate.

10. U. S. P. 1039782, 1912; abst. J. S. C. I. 1912, **31**, 1027; C. A. 1912, **6**, 3917; Mon. Sci. 1913, **79**, 110. For rearrangement of pyrogallol triacetate, see G. Heller, Ber. 1913, **45**, 2389; abst. C. A. 1913, **7**, 83. For manufacture of pyrogallol triacetate, see L. Lederer, D. R. P. 124408, 1901; abst. *Jahr. Chem.* 1901, **54**, II, 1165; *Wag. Jahr.* 1901, **47**, II, 10; *Zts. ang. Chem.* 1901, **14**, 1141; *Chem. Zentr.* 1901, **72**, II, 903; *Chem. Zts.* 1901-02, **1**, 112, 379. He mixes 200 parts of pyrogallol with 500 parts acetic anhydride, and 1 part of conc. sulfuric acid. Heat is evolved, while the precipitation of crystalline triacetate soon commences. The sulfuric acid may be replaced by gaseous

and cinnamate,¹ glyceryl cinnamate,² *m*-cresyl butyrate and isovalerate,³ aniline resinate,⁴ benzylidene acetoacetic ester,⁵ cresyl acetate,⁶ ethyl chlorstearate,⁷ ethyl phthalate,⁸ ethyl lactate,⁹ HCl, or aqueous phosphoric acid.

11. D. B. Ann. C-22897, 1913, abst. Kunst. 1913, **3**, 279, 318.
12. E. P. 3139, 1911; abst. J. S. C. I. 1911, **30**, 888, Chem. Tech. Rep. 1911, **35**, 520. F. P. 425900, 1911; abst. J. S. C. I. 1911, **30**, 951. D. R. P. 246651, 1910; abst. C. A. 1912, **6**, 2529, Chem. Tech. Rep. 1912, **36**, 332, Zts. ang. Chem. 1912, **25**, 1549, Chem. Zentr. 1912, **83**, 1, 1742. Belg. P. 232609, 1911. Aust. P. 29b, A-403, 1911, Mar. 12, 1910, Jan. 14, 1911. D. R. P. 246057, 1910; abst. Kunst. 1912, **2**, 232. Knoll & Co. (D. R. P. 276013, 1912), employ methyl-, ethyl-, propyl-, and *b*-naphthol benzoates (benzonaphthol in conjunction with ethyl tartrate and oleic acid in the production of plastic effects. U. S. P. 972464, 1910, abst. J. S. C. I. 1910, **29**, 1245, Mon. Sci. 1911, (5), **74**, 12; Chem. Tech. Rep. 1911, **35**, 152.
13. U. S. P. 1014859, 1912.
 1. U. S. P. 1000040, 1911.
 2. U. S. P. 999955, 1911.
 3. U. S. P. 1033841, 1912.
 4. U. S. P. 952724, 1910, abst. J. S. C. I. 1910, **29**, 503. E. P. 4154, 1909, abst. J. S. C. I. 1910, **29**, 100. F. P. 402028, 1909, abst. J. S. C. I. 1909, **28**, 1212. D. R. P. 242467, 1908; abst. Kunst. 1912, **2**, 59, C. A. 1912, **6**, 2315, Chem. Tech. Rep. 1912, **36**, 111.
 5. U. S. P. 1031616, 1912, abst. J. S. C. I. 1912, **31**, 770, C. A. 1912, **6**, 2687. E. P. 11354, 1909; abst. J. S. C. I. 1910, **29**, 752. E. P. 18193, 1909; abst. J. S. C. I. 1910, **29**, 575. E. P. 13100, 1910, abst. J. S. C. I. 1911, **30**, 533. F. P. 408370, 1910; abst. J. S. C. I. 1910, **29**, 624. First Add. No. 12469, dated April 13, 1910, abst. J. S. C. I. 1910, **29**, 1299. Second Add. dated June 11, 1910, abst. J. S. C. I. 1910, **29**, 1371. Aust. P. 29b, 4642-10, June 21, 1909.
 6. U. S. P. 695127, 1902. Re. 11997, 1902. E. P. 2264, 1902, abst. J. S. C. I. 1903, **22**, 303. U. S. P. 792149, 1905, abst. J. S. C. I. 1905, **24**, 799, Mon. Sci. 1906, (4), **64**, 22. F. P. 385179, 385180, 1907, abst. J. S. C. I. 1908, **27**, 589; C. A. 1909, **3**, 2383, Mon. Sci. 1909, (4), **70**, 105, 106, Bull. Soc. Chim. 1909, (4), **6**, 557. F. P. 432047, 1911, abst. J. S. C. I. 1912, **31**, 24. First Add. 15719 to F. P. 432047; abst. J. S. C. I. 1912, **31**, 1027, Kunst. 1912, **2**, 415. Belg. P. 241252, 1911. E. P. 20976, 1911.
 - E. P. 8646, 8647, 1910; abst. J. S. C. I. 1911, **30**, 533, 616, Chem. Tech. Rep. 1911, **35**, 307. F. P. 413657, 413658, 1910, abst. J. S. C. I. 1910, **29**, 1101. F. P. 414679, 414680, 1910, abst. J. S. C. I. 1910, **29**, 1199, 1228. Swiss P. 51644, 51910, abst. Kunst. 1912, **2**, 77, 99. Belg. P. 223906, 1910. Aust. 47244. Aust. 53109, abst. Kunst. 1912, **2**, 255.
 - F. P. 432264, 1911, abst. J. S. C. I. 1912, **31**, 24, Kunst. 1912, **2**, 77. First Add. dated Nov. 19, 1912, to F. P. 432264; abst. J. S. C. I. 1913, **32**, 652. Belg. P. 241251, 1911.
 7. U. S. P. 962877, 1910, abst. J. S. C. I. 1910, **29**, 940.
 8. U. S. P. 1031616, 1912; abst. J. S. C. I. 1912, **31**, 770, C. A. 1912, **6**, 2687. E. P. 11354, 1909; abst. J. S. C. I. 1910, **29**, 752. E. P. 18193, 1909; abst. J. S. C. I. 1910, **29**, 575. E. P. 13100, 1910, abst. J. S. C. I. 1911, **30**, 533. F. P. 408370, 1910, abst. J. S. C. I. 1910, **29**, 624. First Add. No. 12469, dated April 13, 1910; abst. J. S. C. I. 1910, **29**, 1299. Second Add. dated June 11, 1910; abst. J. S. C. I. 1910, **29**, 1371. Aust. P. 29b, 4642-10, June 21, 1909. U. S. P. 888518, 1908, abst. J. S. C. I. 1908, **27**, 683, C. A. 1908, **2**, 2866. U. S. P. 904269, 1908; abst. J. S. C. I. 1908, **27**, 1202. E. P. 4597, 1906; abst. J. S. C. I. 1907, **26**, 146. E. P. 592, 1907; abst. J. S. C. I. 1908, **27**, 73; C. A. 1908, **2**, 2018. E. P. 14483, 1903, abst. J. S. C. I. 1903, **22**, 1345. D. R. P. 175664, 1903; abst. Zts. ang. Chem. 1907, **20**, 461. D. R. P. 169782,

amyl lactate,¹ methyl myristate,² oxalate,³ phthalate,⁴ naphthyl acetate,⁵ phenol sulfonate,⁶ acetated castor oil,⁷ toluenesulfonic esters,⁸ ethylidene diacetate,⁹ and ethyl valerianate indicate the range of esters which have been proposed as adjuncts to acetyl-cellulose, in the formation of useful and moldable preparations.

Of the nitro and other nitrogen containing solvents for cellulose acetate which have been brought forward from time to time there may be mentioned as illustrative, acetamide,¹⁰ urea,¹¹ guanidine,

1904 182773, 1904, abst. Zts. ang. Chem. 1907, **20**, 2050

9. U. S. P. 1015156, 1912, abst. Mon. Sci. 1912, **77**, 163. E. P. 1441, 1910; abst. J. S. C. I. 1910, **29**, 1005; Chem. Tech. Rep. 1911, **35**, 340. E. P. 18076, 1910, being First Add. to E. P. 1441, 1910, abst. J. S. C. I. 1910, **29**, 1199. F. P. 412797, 1910, Rev. Chim. Ind. 1910, **21**, 257; abst. J. S. C. I. 1910, **29**, 1005. First Add. 12388, Mar. 19, 1910. D. R. P. 238348, 1909, abst. C. A. 1912, **6**, 1672, Chem. Zentr. 1911, **82**, II, 1085, Chem. Ind. 1911, **34**, 637; Chem. Tech. Rep. 1911, **35**, 520. Chem. Ind. 1911, **34**, 637, Chem. Tech. Rep. 1911, **35**, 520. Abst. P. 47899. Swiss P. 52115, abst. Kunst. 1912, **2**, 99. Can. P. 129265, 1910. F. Redlich (D. R. P. 304224, 1917; abst. J. S. C. I. 1920, **39**, 264-A) advocates diethyl tartrate. Pasterak has patented for the same purpose ethyl, methyl, amyl, and butyl oxalates and lactates, while J. Grolea and J. Weyler (E. P. 123712, 1918, abst. J. S. C. I. 1919, **38**, 714-A) neutral tartaric and citric esters of *n*-butyl, *iso*-butyl and *iso*-amyl alcohols for cellulose acetate combinations. For the rotation-dispersion of butyl, heptyl and octyl tartrates, see P. Frankland and F. Garner, J. C. S. 1919, **115**, 636

1. U. S. P. 999490, 1911, abst. J. S. C. I. 1911, **30**, 1051.

2. U. S. P. 962877, 1910, abst. J. S. C. I. 1910, **29**, 940. U. S. P. 738533, 1903; abst. J. S. C. I. 1903, **22**, 1100. E. P. 26075, 1901, abst. J. S. C. I. 1902, **21**, 1469. F. P. 317008, 1901, abst. J. S. C. I. 1902, **21**, 873.

3. U. S. P. 962877, 1910, abst. J. S. C. I. 1910, **29**, 940.

4. U. S. P. 738533, 1903, abst. J. S. C. I. 1903, **22**, 1100. E. P. 26075, 1901, abst. J. S. C. I. 1902, **21**, 1469. F. P. 317008, 1901, abst. J. S. C. I. 1902, **21**, 873.

5. U. S. P. 1031616, 1912, abst. J. S. C. I. 1912, **31**, 770. C. A. 1912, **6**, 2687. E. P. 11354, 1909, abst. J. S. C. I. 1910, **29**, 752. E. P. 18193, 1909, abst. J. S. C. I. 1910, **29**, 575. E. P. 13100, 1910; abst. J. S. C. I. 1911, **30**, 583. F. P. 408370, 1910, abst. J. S. C. I. 1910, **29**, 624. First Add. No. 12469, dated April 13, 1910, abst. J. S. C. I. 1910, **29**, 1299. Second Add. dated June 11, 1910, abst. J. S. C. I. 1910, **29**, 1371. Aust. P. 296, 4642-10, June 21, 1909. U. S. P. 729990, 1903; abst. J. S. C. I. 1903, **22**, 817. D. R. P. 162230, 1902, abst. Zts. ang. Chem. 1906, **19**, 498, Chem. Centr. 1905, **76**, II, 1000.

6. E. P. 8646, 8647, 1910, abst. J. S. C. I. 1911, **30**, 533, 616, Chem. Tech. Rep. 1911, **35**, 307. F. P. 413657, 413658, 1910; abst. J. S. C. I. 1910, **29**, 1101. F. P. 414679, 414680, 1910, abst. J. S. C. I. 1910, **29**, 1195, 1228. Swiss P. 51644, 51910; abst. Kunst. 1912, **2**, 77, 99. Belg. P. 223996, 1910. Aust. P. 47244. Aust. P. 53109; abst. Kunst. 1912, **2**, 255.

7. U. S. P. 712200, 1902; abst. Mon. Sci. 1903, (4), **60**, 165.

8. F. P. 432264, 1911; abst. J. S. C. I. 1912, **31**, 24; Kunst. 1912, **2**, 77. First Add. dated Nov. 19, 1912, to F. P. 432264, 1911, abst. J. S. C. I. 1913, **32**, 652, Belg. P. 241251, 1911.

9. H. Matheson, Can. P. 198972, 1920.

10. L. Lederer, U. S. P. 774677, 1904; abst. J. S. C. I. 1904, **23**, 1159. E. P. 7088, 1902, abst. J. S. C. I. 1903, **22**, 563. F. P. 319724, 1902, abst.

methylamine,¹ diethyldiphenyl urea,² and diethylamine⁴ as have been employed in acetate lacquers and plastics as ant acids. As a direct solvent,⁴ softener or plastic,⁵ either alone⁶ or in combina-

J. S. C. I. 1902, **21**, 1550, Mon. Sci. 1903, (4), **60**, 123. Add 811, dated Mar 18, 1902, to F. P. 319724, abst. J. S. C. I. 1903, **22**, 563. D. R. P. 145106, 1902; abst. Jahr. Chem. 1904, **57**, 1168, Mon. Sci. 1904, (4), **60**, 93, Zts. ang. Chem. 1903, **16**, 1090, Chem. Centr. 1903, **74**, 11, 1155. D. R. P. 151918, 1902, Add to D. R. P. 145106, abst. Chem. Centr. 1904, **75**, 11, 1180, Jahr. Chem. 1904, **57**, 1168. D. R. P. 152414, 1902, abst. Zts. ang. Chem. 1904, **17**, 1250, Chem. Zentr. 1904, **75**, 11, 382, Wag. Jahr. 1904, **50**, 11, 512; Jahr. Chem. 1904, **57**, 1168. See D. R. P. 189703, being Add. to D. R. P. 152111, abst. Chem. Zentr. 1907, **78**, 11, 1822, Chem. Tech. Rep. 1907, **31**, 570; Wag. Jahr. 1907, **53**, 11, 562, Chem. Zts. 1907, **6**, No. 387, Mon. Sci. 1910, (4), **73**, 159.

11. W. Lindsay, U. S. P. 1045990, 1913, abst. Mon. Sci. 1913, **79**, 110, J. S. C. I. 1913, **32**, 19, C. A. 1913, **7**, 699. U. S. P. 1050065, 1913, abst. Mon. Sci. 1913, **79**, 107, J. S. C. I. 1913, **32**, 133, Kunst. 1913, **3**, 218. U. S. P. 1067785, 1913, abst. Kunst. 1913, **3**, 455, Mon. Sci. 1914, **80**, 38, J. S. C. I. 1913, **32**, 823, C. A. 1913, **7**, 3025. F. P. 10794, 10795, 1910, abst. J. S. C. I. 1911, **30**, 205, 679. F. P. 415517, 415518, 1910, abst. J. S. C. I. 1910, **29**, 1299, Mon. Sci. 1912, **77**, 9. U. S. P. 1027619, 1912, abst. J. S. C. I. 1912, **31**, 583, Mon. Sci. 1912, **77**, 163. The acylation of urea to an acetate does not increase the solvent power for hydrated cellulose acetate, nor is urea acetate an auxiliary solvent in conjunction with acetone or tetrachlorethane. Some of the substituted ureas, however, are energetic solvents, specifically diethyl malonyl urea (veronal, diethylbarbituric acid), a white, crystalline powder, m. pt. 191°, and soluble in about 150 parts cold and 12 parts boiling water. Veronal is readily soluble in acetone and such solutions make useful additions to acetate plastics.

1. E. P. 26502, 1906, abst. J. S. C. I. 1907, **26**, 631. F. P. 371967, 1906, abst. J. S. C. I. 1907, **26**, 340, Mon. Sci. 1908, (4), **68**, 79. Belg. P. 195839, 1906.

2. U. S. P. 1031616, 1912, abst. J. S. C. I. 1912, **31**, 770, C. A. 1912, **6**, 2687. E. P. 11354, 1909, abst. J. S. C. I. 1910, **29**, 752. E. P. 18193, 1909, abst. J. S. C. I. 1910, **29**, 575. E. P. 13100, 1910, abst. J. S. C. I. 1911, **30**, 533. F. P. 408370, 1910, abst. J. S. C. I. 1910, **29**, 624. First Add. No. 12469, dated April 13, 1910, to F. P. 408370, abst. J. S. C. I. 1910, **29**, 1299. Second Add. dated June 11, 1910, to F. P. 408370, abst. J. S. C. I. 1910, **29**, 1371. Aust. P. 296, 4642-10, June 21, 1909.

3. U. S. P. 891218, 1908, abst. J. S. C. I. 1908, **27**, 765, Mon. Sci. 1909, (4), **70**, 116. E. P. 2026-B, 1907, abst. J. S. C. I. 1908, **27**, 353. F. P. 373994, 1907, abst. J. S. C. I. 1907, **26**, 776, Mon. Sci. 1908, (4), **68**, 83, Chem. Tech. Rep. 1907, **31**, 302. D. R. P. 201233, 1906, abst. Chem. Tech. Zts. 1908, **7**, 993, Zts. ang. Chem. 1908, **21**, 2233, Chem. Zentr. 1908, **79**, 11, 994, Jahr. Chem. 1905-08, 11, 982, Chem. Ind. 1908, **31**, 587. D. R. P. 203178, 1906, abst. Chem. Zts. 1909, **8**, 1053, Zts. ang. Chem. 1908, **21**, 2426, Chem. Zentr. 1908, **79**, 11, 1837, Jahr. Chem. 1905-08, 11, 984, Chem. Ind. 1908, **31**, 741.

4. U. S. P. 1005454, 1911, abst. J. S. C. I. 1911, **30**, 1249. E. P. 476, 1910, abst. J. S. C. I. 1910, **29**, 1082. F. P. 411298, 1910, abst. J. S. C. I. 1910, **29**, 978, Phot. Ind. 1910, 1221, Eders. Jahr. 1911, 526. Aust. P. 50656, 1910, abst. Kunst. 1912, **2**, 77. Phot. Ind. 1911, 28, Eders. Jahr. 1911, 526. Belg. P. 222106, 1910. Hung. Anm. M.3691, Dec. 30, 1900. Swiss. P. 51839, 1910; abst. Kunst. 1912, **2**, 77.

5. U. S. P. 1031616, 1912, abst. J. S. C. I. 1912, **31**, 770, C. A. 1912, **6**, 2687. E. P. 11354, 1909, abst. J. S. C. I. 1910, **29**, 752. E. P. 18193, 1909, abst. J. S. C. I. 1910, **29**, 575. F. P. 13100, 1910, abst. J. S. C. I. 1911, **30**, 533. F. P. 408370, 1910; abst. J. S. C. I. 1910, **29**, 624. First Add. No.

tion with shellac,¹ maximum solvent effect is obtained with warm solutions. Methylbenzyltrichloraniline, methylbenzoyltrichloraniline,² trichloraniline,³ the nitranilines,⁴ acetylmethylanilid and ethyl lactate,⁵ acetanilid,⁶ trichlormethylacetanilid, tetra-

12469, dated April 13, 1910, to F. P. 408370, 1910; abst. J. S. C. I. 1910, **29**, 1299. Second Add. dated June 11, 1910, to F. P. 408370; abst. J. S. C. I. 1910, **29**, 1371. Aust. P. 29b, 4642-10, June 21, 1909.

6. U. S. P. 774677, 1904, abst. J. S. C. I. 1904, **23**, 1159. E. P. 7088, 1902; abst. J. S. C. I. 1903, **22**, 563. F. P. 319724, 1902; abst. J. S. C. I. 1902, **21**, 1550; Mon. Sci. 1903, (4), **60**, 123. Add. 811, dated Mar. 17, 1902. F. P. 319724; abst. J. S. C. I. 1903, **22**, 563. D. R. P. 145106, 1902; abst. Jahr. Chem. 1904, **57**, 1168; Mon. Sci. 1904, (4), **60**, 93; Zts. ang. Chem. 1903, **16**, 1090; Chem. Centr. 1903, **74**, II, 1155. D. R. P. 151918, 1902. Add. to D. R. P. 145106; abst. Jahr. Chem. 1904, **57**, 1168; Chem. Centr. 1904, **75**, II, 1180. D. R. P. 152111, 1902.

1. U. S. P. 952724, 1910; abst. J. S. C. I. 1910, **29**, 503. E. P. 4154, 1909; abst. J. S. C. I. 1910, **29**, 100. F. P. 402028, 1909; abst. J. S. C. I. 1909, **28**, 1272. D. R. P. 242467, 1908; abst. Kunst. 1912, **2**, 59. C. A. 1912, **6**, 2315; Chem. Tech. Rep. 1912, **36**, 111.

2. U. S. P. 1031616, 1912; abst. J. S. C. I. 1912, **31**, 770; C. A. 1912, **6**, 2687. E. P. 11354, 1909; abst. J. S. C. I. 1910, **29**, 752. E. P. 18193, 1909; abst. J. S. C. I. 1910, **29**, 575. E. P. 13100, 1910; abst. J. S. C. I. 1911, **30**, 533. F. P. 408370, 1910; abst. J. S. C. I. 1910, **29**, 624. First Add. No. 12469, dated April 13, 1910, to F. P. 408370, 1910; abst. J. S. C. I. 1910, **29**, 1299. Second Add. dated June 11, 1910, to F. P. 408370; abst. J. S. C. I. 1910, **29**, 1371. Aust. P. 29b, 4642-10, June 21, 1909.

3. U. S. P. 1015156, 1912; abst. Mon. Sci. 1912, **77**, 163. E. P. 1441, 1910; abst. J. S. C. I. 1910, **29**, 1005; Chem. Tech. Rep. 1911, **35**, 340. E. P. 18076, 1910. First Add. to E. P. 1441, 1910; abst. J. S. C. I. 1910, **29**, 1199. F. P. 412797, 1910; abst. J. S. C. I. 1910, **29**, 1005; Rev. Chim. Ind. 1910, **21**, 257. First Add. 12388, dated Mar. 19, 1910, to F. P. 412797; abst. J. S. C. I. 1910, **29**, 1199. D. R. P. 238348, 1909; abst. Chem. Ind. 1911, **34**, 637; Chem. Tech. Rep. 1911, **35**, 520; Wag. Jahr. 1911, **57**, II, 552; C. A. 1912, **6**, 1672; Chem. Zentr. 1911, **82**, II, 1085. Aust. P. 47899. Swiss P. 52115; abst. Kunst. 1912, **2**, 99. Can. P. 129265, 1910.

4. U. S. P. 961241, 1910, abst. J. S. C. I. 1910, **29**, 876; Mon. Sci. 1910, (4), **73**, 135. U. S. P. 979960, 1910; abst. J. S. C. I. 1911, **30**, 206; Mon. Sci. 1912, **77**, 30. U. S. P. 981574, 1002408, 1911; abst. J. S. C. I. 1911, **30**, 126, 1157; Mon. Sci. 1912, **77**, 29. E. P. 24284, 1907; abst. J. S. C. I. 1908, **27**, 1150; Mon. Sci. 1911, (5), **74**, 92; F. P. 383636, 1907; abst. J. S. C. I. 1908, **27**, 332. First Add. dated April 5, 1909, to F. P. 383636; abst. J. S. C. I. 1909, **28**, 1199. E. P. 7743, 1909; abst. J. S. C. I. 1910, **29**, 209. D. R. P. 198008, 1907; abst. Chem. Zts. 1908, **7**, 865; Wag. Jahr. 1908, **54**, II, 409; Zts. ang. Chem. 1908, **21**, 1471; Chem. Zentr. 1908, **79**, I, 1809; Chem. Tech. Rep. 1908, **32**, 379; Bull. Soc. Chim. 1909, (4), **6**, 557. D. R. P. 199559, 1907; abst. Zts. ang. Chem. 1908, **21**, 1810; Chem. Zentr. 1908, **79**, II, 271; Bull. Soc. Chim. 1909, (4), **6**, 557. D. R. P. 234028, 1908; abst. Zts. ang. Chem. 1911, **24**, 1151; Wag. Jahr. 1911, **57**, II, 422.

5. A. Eichengrün, U. S. P. 1175728, 1185074, 1916; abst. C. A. 1916, **10**, 1415, 2044; J. S. C. I. 1911, **30**, 79; 1916, **35**, 734. F. P. 418744, 1910.

6. U. S. P. 1031616, 1912; abst. J. S. C. I. 1912, **31**, 770; C. A. 1912, **6**, 2687. E. P. 11354, 1909; abst. J. S. C. I. 1910, **29**, 752. E. P. 18193, 1909; abst. J. S. C. I. 1910, **29**, 575. E. P. 13100, 1910; abst. J. S. C. I. 1911, **30**, 533. F. P. 408370, 1910; abst. J. S. C. I. 1910, **29**, 624. First Add. No. 12469, dated April 13, 1910, to F. P. 408370; abst. J. S. C. I. 1910, **29**, 1299. Second Add. dated June 11, 1910, to F. P. 408370; abst. J. S. C. I. 1910, **29**,

chlorethylacetanilid dissolved in methyl¹ or ethyl alcohol,² are examples of anilids which have been proposed and used.

H. Dreyfus has patented xylenemonomethylsulfonamides xylenemonoethylsulfonamides,³ and toluene-*o*-, and -*p*-mono methylsulfonamide,⁴ while W. Lindsay has described triphenyl phosphate and acetone,⁵ *p*-ethyltoluenesulfonamide,⁶ with trichlorethylene,⁷ or methyl alcohol,⁸ or fusel oil,⁹ or dissolved in a mixture of methyl and ethyl alcohols,¹⁰ or with triphenyl phosphate,¹¹ or methyl acetate or chloroform,¹² triphenyl phosphate with acetone and dichlorhydrin,¹³ camphor,¹⁴ and phenylsalicylate.¹⁵

1371. Aust. P. 29b, 4642 10, June 21, 1909. F. P. 354942, 1905, abst. J. S. C. I. 1905, **24**, 1169; Add. dated June 8, 1905, to F. P. 354942, abst. J. S. C. I. 1905, **24**, 1226. E. P. 12277, 12278, 1905; abst. J. S. C. I. 1906, **25**, 327. D. R. P. 185240, 1906, abst. Zts. ang. Chem. 1907, **20**, 2177, Chem. Zentr. 1907, **78**, II, 1037. D. R. P. 185241, 1906, Add. to D. R. P. 185240; abst. Chem. Zentr. 1907, **78**, II, 1819.
1. U. S. P. 1041117, 1912, abst. J. S. C. I. 1912, **31**, 1075; Mon. Sci. 1913, **79**, 110, C. A. 1912, **6**, 3518. W. Lindsay, U. S. P. 1136248, 1915, abst. J. S. C. I. 1915, **34**, 606.
2. U. S. P. 1041118, 1912, abst. J. S. C. I. 1912, **31**, 1073. See D. R. Ann. L. 30181, 1910, L. 30386, 1910. W. Lindsay, U. S. P. 1216581, 1917; abst. C. A. 1916, **10**, 1301, J. S. C. I. 1917, **36**, 450.
3. E. P. 132283; abst. J. S. C. I. 1919, **38**, 806-A. U. S. P. 1353384, 1920. In connection with this, attention is directed to a cellulose acetate plastic known to the trade as "Elastol," made by the Soc. Chim. des Usines du Rhone, and understood to be a "sulphonamide" compound.
4. E. P. 133353, 1918, abst. J. S. C. I. 1920, **39**, 14-A. U. S. P. 1353384, 1353385, 1920.
5. U. S. P. 1133385, 1916, abst. C. A. 1915, **9**, 1282.
6. U. S. P. 1188797, 1188798, 1916; abst. C. A. 1916, **10**, 2145, 2146; J. S. C. I. 1916, **35**, 887.
7. U. S. P. 1188799, 1188800, 1916, 1229486, 1917, abst. C. A. 1916, **10**, 145; 1917, **11**, 2276; J. S. C. I. 1917, **36**, 887.
8. U. S. P. 1199395, 1916, abst. C. A. 1916, **10**, 3158, J. S. C. I. 1916, **35**, 1215.
9. U. S. P. 1199799, 1199800, 1916; abst. C. A. 1916, **10**, 3159; J. S. C. I. 1916, **35**, 1215.
10. U. S. P. 1203756, 1229487, 1917; abst. C. A. 1916, **10**, 1256; 1917, **11**, 2276; J. S. C. I. 1916, **35**, 1256, 1917, **36**, 869.
11. U. S. P. 1226340, 1226341, 1226342, 1226343, 1917, abst. C. A. 1917, **11**, 2153, 2157; J. S. C. I. 1917, **36**, 707. H. Ross (Can. P. 200433, 1920) coats airplane fabrics with cellulose acetate and triphenyl phosphate.
12. U. S. P. 1229485, 1229486, 1244107, 1244108, 1244347, 1244348, 1244349, 1917; Can. P. 175107, 1917; abst. C. A. 1917, **11**, 2276; 1918, **12**, 95, 242; J. S. C. I. 1917, **36**, 869, 1269. In this connection compare D. R. P. 152131, 189703; see Kunst. 1919, **9**, 187.
13. U. S. P. 1245476, 1917; abst. C. A. 1918, **12**, 424; J. S. C. I. 1918, **37**, 27-A.
14. U. S. P. 1265217, 1917; abst. C. A. 1918, **12**, 1700; J. S. C. I. 1918, **37**, 461-A.
15. U. S. P. 1319229, 1919; abst. J. S. C. I. 1920, **39**, 14-A. See H. Mork, U. S. P. 1246640, 1917; abst. C. A. 1918, **12**, 299.

Acetylmethylaniline (manol) has been described by H. Dreyfus¹ and by A. Eichengruen,² amylienediethyl ether,³ acetylphenylnaphthylamine,⁴ methyl-*o*-toluylenediamine,⁵ β -naphthylamine, β -naphthylaminedihydrocarvone,⁶ and nitronaphthalin,⁷ have also been proposed. Pyridine, quinoline and acridine have been used as a neutralizant in acetation,⁸ and a constituent of acetate lacquers,⁹ in conjunction with tetrachlorethane.¹⁰ Benzidin and dianisidin,¹¹ nitrotoluene,¹² phthalimide,¹³ and *p*-toluene-

1. F. P. 432047, 1911, abst. J. S. C. I. 1912, **31**, 24.^o First Add. 15719, to F. P. 432047; abst. J. S. C. I. 1912, **31**, 1027; Kunst. 1912, **2**, 415. Belg. P. 241252, 1911. E. P. 20976, 1911, abst. C. A. 1913, **7**, 890; J. S. C. I. 1913, **32**, 80; Kunst. 1913, **3**, 175.

2. E. P. 27258, 1910, abst. J. S. C. I. 1911, **30**, 1112; C. A. 1912, **6**, 1526. Can. P. 129983, 1910.

3. Deutsche Zelluloid Fabrik, D. R. P. 132371, 1903; F. P. 312817, 1901.

4. E. P. 12863, 1901. *o*-Nitrofuol is a solvent for partially hydrated cellulose acetate in conjunction with alcohol. Chloracetone is a direct solvent in the cold.

5. E. P. 8077, 1906; abst. J. S. C. I. 1906, **25**, 608.

6. D. R. P. 202720, 1907; abst. J. S. C. I. 1908, **27**, 1220, Zts. ang. Chem. 1908, **21**, 2428; Chem. Zentr. 1908, **79**, 11, 1837; Jahr. Chem. 1905-08, 11, 993; Mon. Sci. 1912, **77**, 57, Wag. Jahr. 1908, **54**, 11, 540, Chem. Tech. Rep. 1908, **32**, 594.

7. F. P. 432264, 1911, abst. J. S. C. I. 1912, **31**, 24; Kunst. 1912, **2**, 77. First Add. dated Nov. 19, 1912, to F. P. 432264, abst. J. S. C. I. 1913, **32**, 652. Belg. P. 241251, 1911.

8. F. P. 418347, 1909, abst. J. S. C. I. 1911, **30**, 96. Add. 15217, to F. P. 418347; abst. J. S. C. I. 1912, **31**, 651, Kunst. 1912, **2**, 316.

9. E. P. 6798, 1912; abst. J. S. C. I. 1912, **31**, 1016. F. P. 429788, 1911; abst. J. S. C. I. 1911, **30**, 1267; C. A. 1912, **6**, 2186, Oil, Paint and Drug Review, April 24, 1912; Chem. Tech. Rep. 1912, **36**, 63.

10. E. P. 20527, 1912. D. R. P. 139669, 1903; abst. Jahr. Chem. 1903, **56**, 1014; Chem. Ind. 1903, **26**, 167, Wag. Jahr. 1903, **49**, 11, 418. Zts. ang. Chem. 1903, **16**, 285, Chem. Centr. 1903, **74**, 1, 744. D. R. P. 243581, 1908; abst. J. S. C. I. 1912, **31**, 381; C. A. 1912, **6**, 2316; Chem. Tech. Rep. 1912, **36**, 196, Zts. ang. Chem. 1912, **25**, 654, Chem. Ind. 1912, **35**, 190; Chem. Zentr. 1912, **83**, 1, 695.

11. U. S. P. 734123, 1903, abst. J. S. C. I. 1903, **22**, 961; Mon. Sci. 1903, **60**, (4), 17, 173. U. S. P. 790565, 1905; abst. J. S. C. I. 1905, **24**, 686. D. R. P. 153350, 1901, abst. Zts. ang. Chem. 1904, **17**, 1697; Chem. Centr. 1904, **75**, 11, 625; Jahr. Chem. 1904, **57**, 1168; J. C. S. 1904, **86**, i, 853; Chem. Ind. 1904, **27**, 538. D. R. P. 159524, 1901, abst. Chem. Centr. 1905, **76**, 11, 527, Zts. ang. Chem. 1905, **18**, 1636; Jahr. Chem. 1905-08, 11, 984; J. C. S. 1906, **90**, i, 6; Chem. Ind. 1905, **28**, 535. E. P. 21628, 1901, abst. J. S. C. I. 1902, **21**, 870. F. P. 317007, 1901; abst. J. S. C. I. 1902, **21**, 870; Mon. Sci. 1903, (4), **60**, 27, 54. Aust. P. 31391. It. P. 62042, 1901.

12. F. P. 432264, 1911; abst. J. S. C. I. 1912, **31**, 24; Kunst. 1912, **2**, 77. First Add. dated Nov. 19, 1912, to F. P. 432264, abst. J. S. C. I. 1913, **32**, 652. Belg. 241251, 1911.

13. U. S. P. 1031676, 1912, abst. J. S. C. I. 1912, **31**, 770; C. A. 1912, **6**, 2687. E. P. 11354, 1909; abst. J. S. C. I. 1910, **29**, 752. E. P. 18193, 1909, abst. J. S. C. I. 1910, **29**, 575. E. P. 13100, 1910; abst. J. S. C. I. 1911, **30**, 533. F. P. 408370, 1910; abst. J. S. C. I. 1910, **29**, 624. First Add. No

sulfamid,¹ are products which have been patented for this purpose.

• The Badische Anilin & Soda Fabrik² have described acetyl-dicyclohexylamine and dicyclohexyltoluenesulfonamide, applicable both to the nitro- and aceto-celluloses as a gelatinizing component. H. Dreyfus³ has described acetyl acetone and ethylidene acetone. General descriptions of cellulose acetate solvents have been published by A. Dubosc,⁴ E. Zimmer,⁵ and P. Leemans.⁶ A confidential report (T-1269, Dec. 1918) has been made by E. Mardles, A. Moses and W. Willstrop to the English Advisory Committee for Aeronautics on the solvents of cellulose acetate, containing a large amount of valuable data.

Commercial Applications of the Cellulose Acetates. The decreased inflammability, combustibility and explosiveness of the cellulose acetates as distinguished from the corresponding nitric esters, has resulted in their gradually replacing them in all arts where ever possible until to-day, the applications of cellulose acetate is becoming almost as varied as with the older and more firmly established pyroxylin arts.

In the formation of moldable compositions ("uninflammable celluloids") an immense amount of careful and painstaking investigation has been and is being expended, as is attested by the malaxateable mixtures of E. Zuhl,⁷ L. Lederer,⁸ J. Schmerber

12469, dated April 13, 1910, to F. P. 408370, 1910, abst. J. S. C. I. 1910, **29**, 1299. Second Add. dated June 11, 1910, to F. P. 408370, abst. J. S. C. I. 1910, **29**, 1371. Aust. P. 290, 4642-10, June 21, 1909.

1 U. S. P. 738533, 1903, abst. J. S. C. I. 1903, **22**, 1100. E. P. 26075, 1901, abst. J. S. C. I. 1902, **21**, 1469. F. P. 317008, 1901, abst. J. S. C. I. 1902, **21**, 873.

2 E. P. 9270, 1914, abst. C. A. 1915, **9**, 2980.

3 E. P. 131669, 1919. In this connection, see the H. Dreyfus F. P. Add. 14783 to F. P. 432046, 1911. D. R. Ann. D-29439, 1913, D-25442, 1912; E. P. 128215. Can. P. 191801, 191801, 191802, 1920.

4 Caout et Gutta-p. 1917, **14**, 19, 9197, 9228, 9251, abst. C. A. 1918, **12**, 94.

5 Farben Ztg. 1918, **23**, 331, abst. C. A. 1919, **13**, 2139.

6 Belg. P. 182052, 1905.

7 U. S. P. 729960, 1903. Zuehl and Eisemann, D. R. P. 162239. For the role of camphor as solvent for acetylcellulose, see A. du Boë, Caout et Gutta-p. 1913, **10**, 7011, abst. Kunst. 1913, **3**, 352. For non-inflammmable celluloid recipes, see Rev. chim. ind. 1909, **20**, 82, 105, C. A. 1909, **3**, 2039.

8 E. P. 9357, 1907, abst. J. S. C. I. 1908, **27**, 589. F. P. 377010, 1907; abst. J. S. C. I. 1907, **26**, 1027, Mon. Sci. 1908, (4), **68**, 444. D. R. P. 152111, 1902, abst. Zts. ang. Chem. 1904, **17**, 1250, Chem. Centr. 1904, **75**, 11, 382; Mon. Sci. 1901, (4), **73**, 159, Jahr. Chem. 1904, **57**, 1168. D. R. P. 189703, 1902, Add. to D. R. P. 152111, 1902; abst. Chem. Zts. 1907, **6**, 387, Chem. Centr. 1907, **78**, 11, 1822, Mon. Sci. 1910, (4), **73**, 159. D. R. P. 220228, 1907, Abst. Chem. Zts. 1910, **9**, 1934; Chem. Ind. 1910, **33**, 271; Chem. Tech.

and L. Morane,¹ F. Bume,² J. Hirsch,³ W. Lindsay,⁴ W. Walker,⁵ C. Mijnessen,⁶ H. Manissadjian,⁷ A. Lumière & Sons,⁸ H. Reeser,⁹ J. Richter,¹⁰ Soc. Anon. Le Camphre,¹¹ C. Ellis,¹² L. Behrend,¹³ B. Rep. 1910, **34**, 180. Aust. P. 34908, 1908; abst. Zts. ang. Chem. 1909, **22**, 505.

1. F. P. 324124, 1902; abst. J. S. C. I. 1904, **23**, 569. E. P. 4863, 1903; abst. J. S. C. I. 1904, **23**, 382.

2. D. R. P. 210519, 1907; abst. J. S. C. I. 1909, **28**, 812; Zts. ang. Chem. 1909, **22**, 1620; Wag. Jahr. 1909, **55**, II, 555.

3. F. P. 324718, 1903; abst. J. S. C. I. 1903, **22**, 620. In F. P. 452432, 1912; abst. C. A. 1913, **7**, 3663, the Soc. Anon. Le Camphre produce plastic films with cellulose acetate and camphor-addition compounds.

4. U. S. P. 1041118, 1912; abst. J. S. C. I. 1912, **31**, 1075; C. A. 1912, **6**, 3518. U. S. P. 1041116, 1912; abst. C. A. 1912, **6**, 3518; Mon. Sci. 1913, **79**, 110.

5. U. S. P. 774713, 1904; abst. J. S. C. I. 1904, **23**, 1159, Mon. Sci. 1905, (4), **62**, 50. U. S. P. 774714, 1904; abst. J. S. C. I. 1904, **23**, 1159.

6. U. S. P. 1005454, 1911; abst. J. S. C. I. 1911, **30**, 1249. E. P. 476, 1910; abst. J. S. C. I. 1910, **29**, 1082. F. P. 411298, 1910; abst. J. S. C. I. 1910, **29**, 978; Phot. Ind. 1910, 122f. Eders Jahr. 1911, 526. Aust. P. 50650, 1910; abst. Kunst. 1912, **2**, 77; Phot. Ind. 1911, 28. Ital. P. 115776, 1911. Belg. P. 222106, 1910. Hung. Anm. M.-3691, Dec. 30, 1909. Swiss P. 51839, 1910; abst. Kunst. 1912, **2**, 77.

7. ~~1904~~ 27201, 1908. Swiss P. 43330, 1907. Hung. Appl. M-3798, 1910. See Snowden & Co., Belg. P. 241975, 1912; F. P. 437411, 1911. Hung. Appl. S-6073, 1912. Acetylcellulose solvents, A. Wohl, Hung. Appl. W-2966, 1911; W-3204, 1911; Belg. P. 241116, 1911. For plastic, solid formylcellulose solutions, consult Vereinigte Glanzstoff Fabriken, Hung. Appl. G-3096, G-3210, G-3306; Swiss P. 55942, 1911. Nitritfabrik, Akt.-Ges., Aust. Appl. 5655, 1909. Hung. Appl. K-3937. Weber and Cross, Swed. P. 10976. G. Meyer, Aust. appl. 1793 of 1911. H. Reeser, Hung. Appl. R-2398, 1909. C. Mijnessen, Hung. Appl. M-3691, 1909. Manufacture of cellulose fatty-acid esters, Society of Chemical Industry, Basle. E. P. 21016, 1914. In F. P. 463610; abst. Kunst. 1914, **4**, 293, U. S. P. 774677, 1904; in a more recent patent (E. P. 8945, 1909) it is stated that durable softness and suppleness may be produced in cellulose acetate by the addition of a "small proportion of an organic acid ester of a monohydric phenol or of a phenol either of a homologue or nuclear substitution product of these substances." D. R. P. 145-106, 151918, 1902; phenol, resorcin, pyrogallol, naphthol, aminophenol, saligenin, nitrophenol salicylic acid esters, all being claimed as efficient. D. R. P. 152111, 1902. In F. P. 330714, 1903, Lederer, cellulose acetates are shaped into threads, ribbons, films, tubes, etc., by discharging thick solutions of them through suitably shaped orifices into liquids which dissolve out the solvent without dissolving the cellulose compounds. For instance, a solution of cellulose acetate in acetic acid or phenol is discharged into alcohol and the precipitated product subsequently dried. In D. R. P. 185151; abst. Jahr. Chem. 1905-08, II, 985; Wag. Jahr. 1907, **53**, II, 403, Lederer obtains solid acetylcellulose plastic compounds by precipitating the crude ester from the acetylating bath by means of carbon tetrachloride. Compare Aust. Anm. 3060 of 1909. For review of recent patents see J. Reitsstötter, Kunst. 1919, **9**, 185.

8. F. P. 401228.

9. Belg. P. 216668, 1909. E. P. 12976, 1909; no patent granted; abst. J. S. C. I. 1910, **29**, 147. F. P. 411126, 1909; abst. J. S. C. I. 1910, **29**, 875; Mon. Sci. 1912, **77**, 8. Aust. P. 9533, 1909. Hung. Anm. R.-2398, Dec. 23, 1909. Port. P. 7102, 1909.

10. D. R. P. 246081, 1911; abst. C. A. 1912, **6**, 2529; Chem. Tech. Rep.

Szelinski,¹ H. Cathelineau and A. Rene,² G. Convert,³ H. Dreyfus,⁴ P. Leeman,⁵ W. Lindsay,⁶ W. Beatty,⁷ A. Eichengrün,⁸ Knoll & Co.,⁹ E. Ichenhauser,¹⁰ Y. Charuel,¹¹ L. Grate,¹² Soc. 1912, **36**, 323

11. F. P. 452432, 1912, abst J S C I 1913, **32**, 652, Kunst 1913, **3**, 295 D. R. Ann. R. - 32631, 1911.

12. U S P. 999490, 1911, abst J S C I 1911, **30**, 1051

13. U S P. 952724, 1910, abst J S C I 1910, **29**, 503 E. P. 4154, 1909; abst J S C I 1910, **29**, 100 F. P. 402028, 1909, abst J S C I 1909, **28**, 1212 D. R. P. 242467, 1908, abst Kunst 1912, **2**, 59, C. A. 1912, **6**, 2315, Chem. Tech. Rep. 1912, **36**, 111, Wag. Jahr 1912, **58**, 11, 616

1. D. R. P. 206720, 1907, abst J S C I 1908, **27**, 1220, Zts. ang. Chem. 1908, **21**, 2428, Chem. Zentr. 1908, **79**, 11, 1837, Jahr. Chem. 1905-08, 11, 993; Mon. Sci. 1912, **77**, 57

2. F. P. 354942, 1905, abst J S C I 1905, **24**, 1169 Add. dated June 8, 1905, to F. P. 354942, abst J S C I 1905, **24**, 1226 E. P. 12277, 12278, 1905, abst J S C I 1906, **25**, 325 D. R. P. 185240, 1906, abst Zts. ang. Chem. 1907, **20**, 2177, Chem. Zentr. 1907, **78**, 1037 D. R. P. 185241, 1906, Add. to D. R. P. 185240, abst Chem. Zentr. 1907, **78**, 11, 819

3. F. P. 421843, 1910, abst J S C I 1911, **30**, 115

4. F. P. 432264, 1911, abst J S C I 1912, **31**, 21, Kunst 1912, **2**, 77

First Add. dated Nov. 19, 1912, to F. P. 432264, abst J S C I 1913, **32**, 652 Belg. P. 241251, 1911 Compare also the E. P. 20975, 1911, abst C. A. 1913, **7**, 890, Kunst 1913, **3**, 215 In F. P. 432264, 1912, abst C. A. 1913, **7**, 3414, Swiss P. 63584, 1911, abst C. A. 1914, **8**, 2252, Dreyfus claims to produce in combustible celluloid by replacing tetrachlorethane by aromatic silicon and boron compounds, which are said to possess the advantage over the phosphoric esters in not decomposing the acetylcellulose Triphenyl borate, tri cresyl borate are included In a more recent patent (F. P. 461544, 1913, abst Kunst 1914, **4**, 137), plastic cellulose acetate compounds are described as obtainable from the introduction of the glycerol esters of aromatic carboxyl acids See also Can. P. 155724, 1914, abst C. A. 1914, **8**, 2927 Swiss P. 63584, 63585, abst Kunst 1914, **4**, 216

5. Belg. P. 181194, 182050, 182051, 182052, 1905, 201017, 1907

6. U S P. 1041113, 1912, C. A. 1912, **6**, 3517, J S C I 1912, **31**, 1075, Mon. Sci. 1913, **79**, 110

7. F. P. 447645, 1912, abst J S C I 1913, **32**, 283, Mon. Sci. 1914, **78**, 14, Kunst 1913, **3**, 116 Can. P. 147578, 147579, 1913, abst C. A. 1913, **7**, 2127, 2128 Belg. P. 252594, 1913, abst Kunst 1913, **3**, 276 E. P. 18822, 1912, abst J S C I 1912, **32**, 907 D. R. Ann. B. 68616, 1912, abst Kunst 1914, **4**, 280 Aust. P. 63966, abst Kunst 1914, **4**, 257

8. A. Eichengrün, E. P. 18189, 1910 F. P. 418744, 1911, abst J S C I 1911, **30**, 79, 798 See also E. P. 19735, 1908, D. R. P. 210519 D. R. P. Ann. E-17039 India P. Appl. 45, 1911 Can. P. 139235, 1912

9. D. R. P. 255704, 1911, abst J S C I 1913, **32**, 421, C. A. 1913, **7**, 807; Kunst 1913, **3**, 951; D. R. Ann. K. 48996, Sept. 12, 1911, Chem. Ztg. 1912, **34**, 1174 See also Knoll & Co., D. R. Ann. K. 52789, K. 52025, K. 48490 E. P. 16905, 1913 D. R. P. 255704, 1911 Hung. Appl. K-5168, 1912. In their D. R. P. 255704, 1911 Hung. Appl. K-5168, 1912 In their D. R. P. 276013, 1912, abst J S C I 1914, **33**, 916, Kunst 1914, **4**, 300, white, colored or opaque objects are prepared from primary acetylcellulose solutions by the use of an aromatic ester or ether which does not decompose acetylcellulose, such as methyl-, ethyl- or β -naphthyl phthalates, benzyl chloride or anisol, which are added to the acetylcellulose while still in the acetylating bath or before acetylation. The resulting mixture is heated for a short time until a clear solution is obtained, when the acetylated product is precipitated in the usual manner by water, saline solutions or alcohol White,

Anon. Nouvelle l'Oyonnithé,¹ A. Pueschel,² and L. Collardon.³
 The Cellon of F. Bayer & Co.,⁴ and the Cellonite and Spondite

opaque and stable filaments or films are thus formed which may be colored by the addition of suitable dyestuffs to the solution

In D. R. P. 275962, 1911, abst. J. S. C. I. 1914, **33**, 916; Kunst. 1914, **4**, 317, Knoll & Co. effect a regular and systemic reaction of cellulose with organic acids, by circulating the esterifying agent through a series of vessels containing cellulose in varying stages of acetylation, in such a manner that it comes in contact in successive vessels with cellulose in a lower state of esterification. A diluent in which the resulting ester is insoluble may be added to the esterifying agent, the presence of a catalyst being advantageous

D. R. P. 276013, 1912. See also Knoll & Co., D. R. P. 273706, 1911, same as F. P. 442512, C. A. 1913, **7**, 1288; 1914, **8**, 2948. D. R. P. 274260, 1912. D. R. Ann. K. 36905, 1908. The process of G. Meyer (Aust. P. 55654, D. R. Ann. M. 42978, 1910, abst. Kunst. 1913, **3**, 38), is somewhat similar, the acetone soluble or ethyl acetate soluble acetylcellulose being precipitated by non-solvents and incorporated with camphor substitutes.

10. F. P. 436538, 1911, abst. J. S. C. I. 1911, **31**, 485.

11. F. P. 463156, 1913, abst. J. S. C. I. 1914, **33**, 417; C. A. 1914, **8**, 2817.

12. E. P. 23728, 1912; abst. J. S. C. I. 1913, **32**, 1104.

1. F. P. 465315, 1913; abst. J. S. C. I. 1914, **33**, 478.

2. E. P. 18105, 1913, abst. J. S. C. I. 1914, **33**, 20; Kunst. 1914, **4**, 194; F. P. 461121, 1913; abst. J. S. C. I. 1914, **33**, 196. D. R. P. 270580, 1913; abst. C. A. 1914, **8**, 2252; Kunst. 1914, **4**, 155; D. R. Ann. P. 31300, 1913; abst. Kunst. 1913, **3**, 139, 1914, **4**, 80. Belg. P. 259019; Aust. P. 65040, abst. Kunst. 1914, **4**, 238, 274.

3. U. S. P. 830493, 1906; 1105619, 1914, abst. C. A. 1914, **8**, 3244.

4. For general articles on Cellit and its applications, see Sci. Amer. 1908, **98**, 370, 1912, **107**, 145. F. Beltzer, Mon. Sci. 1908, **68**, 648; abst. J. S. C. I. 1908, **27**, 1037, Mon. Sci. 1910, (4), **70**, 145, abst. C. A. 1910, **4**, 1238; Chem. Zentr. 1910, **81**, 11, 509. L. Clement and C. Riviere, La Rev. de Chim. Ind. 1911, **22**, 215. Caout. and Gutta p. 1911, **8**, 5449, abst. C. A. 1911, **5**, 3908. A. Eichengrün, Zts. ang. Chem. 1907, **20**, 922; 1911, **24**, 366. U. S. Daily Consular and Trade Report, Oct. 27, 1908, No. 3315, 13; Jour. Soc. Arts, 1908, **56**, 1009, 1908, **57**, 78. Phot. Dealer London, 1909, 24; Chem. Ztg. 1908, **32**, 583; Zts. ang. Chem. 1908, **21**, 1729, abst. Chem. Zentr. 1908, **79**, 11, 215; Zts. ang. Chem. 1908, **21**, 1351, Bull. Soc. Chim. 1909, (4), **6**, 74; Zts. ang. Chem. 1911, **24**, 1306; abst. Kunst. 1911, **1**, 452. Oest. Chem. Ztg. 1911, **14**, 59; abst. J. S. C. I. 1911, **30**, 413; C. A. 1911, **5**, 2429. Apoth. Ztg. 1911, **26**, 206; abst. Mercks Report 1911, **20**, 176; Zts. ang. Chem. 1911, **24**, 366; abst. Chem. News, 1911, **103**, 293, 1911, **104**, 203; Jour. Eng. Chem. 1911, **3**, 437. Fabrik. Fuhrwehrr, 1908, **15**, 61. Seifenfabr. 1908, **28**, 946; Chem. Ztg. 1908, **32**, 538; Zts. ang. Chem. 1908, **21**, 1729. Phot. Wochbl. 1908, **19**, 702. Z. Drechsler, 1908, **31**, 375. Am. Apoth. 1908, **29**, 40. C. Hennings, Photog. Jour. 1913, 10. Kunst. 1913, **3**, 298. Kunst. 1911, **1**, 93. A. Eichengrün, D. R. P. 287745, 1910, 295764, 1916, 296205, 1917; Belg. P. 222416, 1910, abst. C. A. 1916, **10**, 2145, Chem. Zentr. 1915, **86**, I, 864; 1917, **87**, I, 463, 296; Kunst. 1915, **5**, 274; F. Meyer, U. S. P. 1175791, 1916; F. P. 333963, 1908, Swiss P. 44833, 1908, abst. J. S. C. I. 1909, **28**, 257, 1916, **35**, 539.

Stotz & Co. Elektrizitäts Ges., Chem. Ztg. 1918, **42**, 266; abst. Chem. Zentr. 1918, **89**, II, 489. S.-t. Umschau, 1917, **21**, 613; abst. Chem. Zentr. 1917, **88**, II, 572. Anon., Elektrochem. Zts. 1916, **37**, 109; abst. C. A. 1916, **10**, 1439. Diamant, **37**, 485, abst. C. A. 1915, **9**, 2973. Andes, Farb. Ztg. 1918, **24**, 128, Kunst. 1919, **9**, 123. Neuste Erfind. Erfahr. 1919, 274. E. Parade, D. R. P. 311500, 1915; Kunst. 1919, **38**, 180.

of H. Dreyfus,¹ are cellulose acetate plastics. Other plastic cellulose acetates have been described by Badische Anilin & Soda Fabrik,² Balland & Co.,³ F. Bayer & Co.,⁴ W. Bonner,⁵ G. Diesser,⁶ B. Gaisenband and Casimir-Stanislas Picottrak,⁷ Hertzman,⁸ G. Koller,⁹ H. Levey,¹⁰ L. Lilienfeld,¹¹ W. Lindsay,¹² W. Mooser-Schiess,¹³ H. Mork and G. Esselen,¹⁴ W. Merckens and H. Manisadjian,¹⁵ Peachey,¹⁶ W. Plinatus,¹⁷ W. Stevenson,¹⁸ and Verein für Chemische Industrie, Frankfurt.¹⁹

Cellon, Sicoil,²⁰ Cellulette,²¹ Boroid, Spondite and Argonite

1. U. S. P. 1181858, 1916, 1242783, 1917, 1315180, 1919, E. P. 20976 1913, 114304, 118891, 127615, 127678, 132283, 1918, 133353, E. P. Appl. 13209, 1917; 14680, 20975, 1919, F. P. 43, 1917, 1911, Add. Oct. 31, 1913, Swiss P. 63584, 1911, abst. C. A. 1911, **8**, 2252, 1916, **10**, 1789, 1918, **12**, 1512, 1919, **13**, 73, 1920, **14**, 316, J. S. C. I. 1912, **31**, 21, 1027, 1916, **35**, 40, 686, 1917, **36**, 1232, 1918, **37**, 661 A, 687 A, 1919, **38**, 416 A, 531 A, 811 A, 848 A.
2. D. R. P. 284672, 1915, abst. Chem. Zentr. 1915, **86**, II, 111.
3. E. P. 473189, abst. J. S. C. I. 1915, **34**, 514.
4. E. P. 26075, 1901, abst. J. S. C. I. 1902, **21**, 1169. D. R. P. 292589, 1916, abst. Chem. Zentr. 1916, **87**, II, 205.
5. U. S. P. 1173337, 1916, abst. C. A. 1916, **10**, 1081.
6. E. P. 11166, 1909, 16615, 1912.
7. F. P. 483316, 1917, abst. C. A. 1918, **12**, 995.
8. Aust. P. 29281, 29831, 1905.
9. Aust. Ann. 1297, 1912, abst. Chem. Ztg. 1913, **37**, 216.
10. U. S. P. 1295533, 1316311, 1919, abst. C. A. 1919, **13**, 255, 3011, J. S. C. I. 1919, **38**, 357 A, 897 A.
11. E. P. 15657, 1911, Hung. Ann. 13291, abst. Chem. Ztg. 1913, **37**, 11.
12. U. S. P. 1133385, 1915, 1199798, 1199800, 1916, 1265217, 1918, 1319229, 1919, F. P. 415517, 1910, abst. C. A. 1915, **9**, 1282, 1916, **10**, 3159, 1920, **14**, 223; J. S. C. I. 1910, **29**, 1299, 1916, **35**, 1215.
13. U. S. P. 1317721, 1919, abst. C. A. 1919, **13**, 3289.
14. U. S. P. 1193178, 1916, abst. J. S. C. I. 1916, **35**, 961.
15. Swiss P. 51644, 51960, 51970, 1910. Aust. P. 47679. E. P. 8646, 1910.
16. E. P. 121091, 1914, 1918, abst. J. S. C. I. 1918, **37**, 788 A.
17. E. P. 16940, 1913, F. P. 476991, 1914, abst. J. S. C. I. 1915, **34**, 793, 1916, **35**, 597.
18. E. P. 138379, 1920, abst. C. A. 1920, **14**, 1879.
19. D. R. P. 303018, 1912, abst. J. S. C. I. 1918, **37**, 267 A.
20. U. S. P. 1015456, 1912, abst. Mon. Sci. 1912, **77**, 163. E. P. 1441, 1910; abst. J. S. C. I. 1910, **29**, 1005, Chem. Tech. Rep. 1911, **35**, 340. E. P. 18076, 1910, First Add. to E. P. 1441, 1910, abst. J. S. C. I. 1910, **29**, 1199, F. P. 412797, 1910, abst. J. S. C. I. 1910, **29**, 1005, Rev. Chim. Ind. 1910, **21**, 257. First Add. 12388, dated Mar. 19, 1910, to F. P. 412797, abst. J. S. C. I. 1910, **29**, 1199. D. R. P. 238348, 1909, abst. chem. ind. 1911, **34**, 637, Chem. Tech. Rep. 1911, **35**, 520, C. A. 1912, **6**, 1672, Chem. Zentr. 1911, **82**, II, 1085; Aust. P. 47899; Swiss P. 52115, abst. Kunst. 1912, **2**, 99. Can. P. 129265, 1910. For article on "Cellon," see Zts. ang. Chem. 1911, 366, Jour. Ind. Eng. Chem. 1911, **3**, 437.
21. J. Dew, London, manufactures a non-flam cellulose acetate film called "Cellulette."

are commercial names for various cellulose acetate thermoplastic compounds.

In the manufacture of readily flowable solutions—acetate lacquers¹⁻⁴ many and diversified are the solvent and ester combinations which have been brought forward from time to time. Among these may be mentioned the processes of G. Koller,² L. Lederer,³ W. Walker,⁴ Societe Debaugé et Cie,⁵ H. Peters,⁶ Societe Leduc Heitz et Cie,⁷ Badische Anilin und Soda Fabrik,⁸ F. Bayer & Co.,⁹ Chemische Werke vorm. H. Byk,¹⁰ Becker,¹¹ G. Blatt,¹²

1. For general article see Kunst. 1912, **2**, 239, L. Clement, Mat. grass. 1911, 2423; Kunst. 1912, **2**, 32. Rathgens, N. Erfind. Erfahr. 1917, 404; abst. Kunst. 1919, **3**, 187.

2. U. S. P. 1079773, 1914, abst. C. A. 1914, **8**, 421.

3. U. S. P. 804960, 1905, abst. J. S. C. I. 1905, **24**, 1314. E. P. 6751, 1905; abst. J. S. C. I. 1906, **25**, 326. F. P. 352897, 1905, abst. J. S. C. I. 1905, **24**, 978, 984, Mon. Sci. 1907, (4), **66**, 33. D. R. P. 175379, 1904; abst. Mon. Sci. 1908, (4), **68**, 43, Zts. ang. Chem. 1907, **20**, 2045; Chem. Centr. 1906, **77**, II, 1544, Jahr. Chem. 1905-08 II, 984. D. R. P. 188542, 1905; abst. Mon. Sci. 1910, (4), **72**, 77, Chem. Zts. 1907, **6**, No. 258, Chem. Zentr. 1907, **78**, II, 1815, Jahr. Chem. 1905-1908, II, 984. For the acetation of cellulose to preserve its structural form in the presence of carbon tetrachloride, see Lederer, Belg. P. 195840, 1906.

4. U. S. P. 1035108, 1912, claim 6 covering the manufacture of solutions suitable for industrial purposes by dissolving acetylcellulose in acetylene tetrachloride. For Lederer vs. Walker on this patent, see 179 Off. Gaz. 851, and 182 Off. Gaz. 511-514.

5. F. P. 418347, 1909; abst. J. S. C. I. 1910, **29**, 1117, 1911, **30**, 96. Addition No. 15217 of 1912 to F. P. 418347; abst. Kunst. 1912, **2**, 316, covers the use of hexachlorethane in tetrachlorethane solution with cellulose acetate for lacquer purposes. For the Chemische Fabrik Griesheim-Elektron method of preparing lacquers, see D. R. Ann. C-22873, 1912, Kunst. 1913, **3**, 479.

6. E. P. 14293, 1910; abst. J. S. C. I. 1911, **30**, 1171.

7. F. P. 429788, 1911; abst. J. S. C. I. 1911, **30**, 1267, Belg. P. 251795; abst. Chem. Ztg. 1913, **37**, 254. F. Botrelle and G. Fretard, Belg. P. 242735; Mon. Sci. 1913, **78**, 39; C. A. 1912, **6**, 2186, Oil, Paint and Drug Review, Apr. 24, 1912. For résumé of use of acetylene tetrachloride in cellulose acetate lacquers containing nothing new, see L. Clement and C. Riviere, Caout. et Gutta-p. 1912, **8**, 5615-16.

8. D. R. P. 251351, 1911; abst. Wag. Fahr. 1912, **58**, II, 604; C. A. 1913, **7**, 351, 427, 1426, Chem. Tech. Rep. 1912, **36**, 584; Chem. Ind. 1912, **35**, 657, Zts. ang. Chem. 1912, **25**, 2508, Chem. Zentr. 1912, **83**, II, 1246, Farb. Ztg. 1912, **17**, 2815. U. S. P. 1045895, 1913; E. P. 3869, 7292, 1912; abst. J. S. C. I. 1912, **31**, 1176; F. P. 440733, 1912; abst. J. S. C. I. 1912, **31**, 828; Kunst. 1912, **2**, 414; 1913, **3**, 17; Mon. Sci. 1914, **80**, 14. See also their D. R. P. Ann. B-64397, 1911.

9. D. R. P. 256922, 1911, abst. Chem. Zentr. 1913, **84**, I, 1156; Kunst. 1913, **3**, 213; C. A. 1913, **7**, 2116, J. S. C. I. 1913, **32**, 530. See also their D. R. P. 281374, 1915; of 1911, being addition to D. R. P. 256922; abst. Kunst. 1913, **3**, 420. According to their D. R. P. 268627, 1911, abst. Kunst. 1911, **4**, 90, abs. Chem. Zentr. 1913, **84**, I, 1156, 1915, **86**, I, 235, alcoholic cellulose acetate solutions may be prepared by the action of stannic chloride (tin tetrachloride) or antimony trichloride (antimonous chloride) upon the alcohol-insoluble cellulose acetates. For instance, if to a solution of 64 parts of stannic chloride in 60 parts of alcohol, there is added 10 parts of acetone-soluble

Cellon, Ltd., Tyrer & Co., Chambers and Feasey,¹ Chemische Fabrik Griesheim Elektron,² L. Clement and C. Riviere,³ H. Dreyfus,⁴ A. Eichengrün,⁵ Gilmour and Dunville & Co.,⁶ S. Groves and T. Ward,⁷ P. Hewitt,⁸ Chemische Fabrik von Heyden,⁹ J. Huebner,¹⁰ Internationale Celluloseester Ges.,¹¹ M. Jenett and M. List,¹² Macdonald,¹³ P. Roder,¹⁴ O. Silberrad,¹⁵ Societe Anon. des Etablissements Hutchinson,¹⁶ Verein für Chemische Industrie in Mainz,¹⁷ The Viscose Development Co., Ltd.,¹⁸ A. Zimmer, J. Bryce, and G. Davies.¹⁹

The cellulose acetate lacquers intended primarily as coatings for aeroplane wings as typified by the Aerolac developed by Dr. acetylcellulose, after standing for some hours, the alcohol soluble modification is eventually formed. On 2.5 parts of chloroform soluble acetylcellulose when treated with 50 parts of acetone trichloride in 50 parts of alcohol, gradually becomes soluble in alcohol.

10. F. P. 464617, 1913, abst. J. S. C. I. 1914, **33**, 557; C. A. 1914, **8**, 3364.
11. Collegium, 1915, 258, abst. Chem. Zentr. 1915, **86**, II, 482. See also 4) R. P. Ann. C. 19056, abst. Chem. Ztg. 1913, **37**, 272.
12. D. R. P. 297030, 1917, abst. Chem. Zentr. 1917, **88**, I, 940.
1. E. P. 130102, abst. J. S. C. I. 1919, **38**, 608 A.
2. D. R. P. 281373, 1915, abst. Chem. Zentr. 1915, **86**, I, 233.
3. U. S. P. 1173331, 1916, F. P. 461058, 1913, abst. C. A. 1916, **10**, 1104; J. S. C. I. 1914, **33**, 20, 1916, **35**, 165, Bull. Soc. Encour. ind. nat. 1914, **121**, 187, abst. C. A. 1915, **9**, 1253.
4. F. P. 432264, 1911, Add. 20264, 1917, Add. dated Sept. 12, 1913, March 4, 1914, June 30, 1914, D. R. P. Ann. D. 30733, 1914, abst. C. A. 1918, **12**, 1350, Kunst. 1915, **5**, 72; J. S. C. I. 1913, **32**, 652, 1916, **35**, 40. See Kunst. 1919, **9**, 204.
5. Austral. P. 46, 1911.
6. E. P. 131647, abst. J. S. C. I. 1919, **38**, 700-A.
7. E. P. 128659, 1917, abst. C. A. 1919, **13**, 3028.
8. U. S. P. 1188655, 1188775, 1188776, 1188777, 1916, E. P. 16271, 1911, abst. C. A. 1916, **10**, 2157; J. S. C. I. 1916, **35**, 898.
9. D. R. P. Ann. C. 26939, 1917, abst. Chem. Zentr. 1919, **90**, II, 386.
10. E. P. 127027, 1917, abst. C. A. 1919, **13**, 2443; J. S. C. I. 1919, **38**, 678-A.
11. D. R. P. 300908, 1917, abst. Chem. Zentr. 1917, **88**, II, 716.
12. Chem. Tech. Wochen. 1918, 287.
13. E. P. Appl. 16017, 1918, abst. J. S. C. I. 1918, **37**, 640 A.
14. D. R. P. 280111, 1913, Aust. P. 63556, 67697, 69736.
15. E. P. Appl. 26458, 1919, abst. J. S. C. I. 1919, **38**, 848-A.
16. E. P. 129630, 1919, abst. C. A. 1919, **13**, 3027. In this connection, see Aircraft Fireproofing Corporation and P. Bradley, Can. P. 201664, 201665, 1920. H. Ross, Can. P. 198265, 1920. A. Flatters, E. P. 129455, 1918, abst. C. A. 1919, **13**, 3020. A. Chapman, Chem. Age, 1920, **2**, 438; abst. C. A. 1920, **14**, 2080. Vickers Ltd. and J. McKeehine, E. P. 142615, 1920; abst. J. S. C. I. 1920, **39**, 482-A. All the above are in relation to the use of cellulose acetate in the airplane industry.
17. D. R. P. 296206, 1917, Chem. Zentr. 1917, I, 462.
18. Aust. P. 66165. M. Althausse, U. S. P. 692775, 1902.
19. E. P. 124807, 1919, abst. J. S. C. I. 1919, **38**, 273-A. Anhydrot-Leder Werke A. C. and K. Haring, E. P. 28392, 1912, 14868, 1914.

Samuel Isermann for the Chemical Co. of America, belong to this class.

Especially in connection with varnishes and lacquer for the protection of the canvas of the wings of airplanes from the air and sun, has ingenuity and thought been expended due to the immense amounts of cellulose acetate used for this purpose in the conflict so recently closed. Investigators in this field who have devised preparations of this nature are J. Goldsmith,¹ A. Beck and J. Nicholson & Sons,² Boake and Boake and Roberts & Co.,³ British Aeroplane Varnish Co. and S. Groves,⁴ British Emailite Co.,⁵ F. Cumbers and The British Cellulose and Chemical Manufacturing Co., Ltd.,⁶ Cello, Ltd., and A. Barr,⁷ L. Clement and C. Riviere,⁸ W. Doerflinger,⁹ C. Dreyfus,¹⁰ Dunville & Co., and Gilmour,¹¹ E. I. Du Pont de Nemours Co.,¹² F. Sage & Co., Ltd., and N. Feary,¹³ D. Frothingham and R. Sawyer,¹⁴

1. U. S. P. 1298199, 1919, E. P. 124515, 1916, abst. C. A. 1919, **13**, 1771.

2. E. P. 131899, 1920. W. Doerflinger, D. R. Ann. D-23476, 1910.

3. E. P. Appl. 9751, 1919, abst. J. S. C. I. 1919, **38**, 310-A.

4. E. P. 128974, 1917, abst. C. A. 1919, **13**, 3028, J. S. C. I. 1919, **38**, 518-A. British Aeroplane Varnish Co. and Ward, E. P. 129033, 1919; abst. J. S. C. I. 1919, **13**, 517-A. Groves and Ward, E. P. App. 7177, 1918. E. P. 128659, 1917, abst. J. S. C. I. 1919, **38**, 518-A.

5. E. P. 1019, 1914, abst. J. S. C. I. 1915, **34**, 867. The British Emailite Co., and J. Goldsmith, E. P. 124515; U. S. P. 1298199; abst. J. S. C. I. 1919, **38**, 378-A, 472-A. See also Flight, 1919, 952. J. S. C. I. 1916, **35**, 46, 1917, **36**, 51, 1918, **37**, 80-A.

6. E. P. 131584, 1918, abst. J. S. C. I. 1919, **38**, 759-A. See R. P. Appl. 13796, 13926, 1920.

7. E. P. 129698, 1919, abst. J. S. C. I. 1919, **38**, 558-A. Cello Ltd., Tyrer & Co., Chambers and Feasey, E. P. 130402; abst. J. S. C. I. 1919, **38**, 608-A. Cello Ltd., Tyrer & Co. and Tucker, E. P. 123628, abst. J. S. C. I. 1919, **39**, 207-A. A. Barr and H. Lazell, E. P. 131641, 1918, abst. J. S. C. I. 1919, **38**, 834-A. C. A. 1920, **14**, 359.

8. U. S. P. 1173931, E. P. 461058, 1910, abst. J. S. C. I. 1914, **33**, 20, 465. The photographic film of the Celluloid Co. (E. P. 482239, 1917; C. A. 1917, **11**, 3182). Can. P. 175107, 1917, consists of cellulose acetate, triphenyl phosphate and fusel oil.

9. U. S. P. 1315216, 1919, abst. C. A. 1919, **13**, 3028, J. S. C. I. 1919, **38**, 834-A.

10. E. P. 100180, 126347, 1916, abst. J. S. C. I. 1916, **35**, 887, 1919, **38**, 496-A. H. Dreyfus, U. S. P. 1315480, 1919, 1280974; E. P. 118891, 128274, 131669, abst. C. A. 1919, **13**, 73, 3011, J. S. C. I. 1919, **38**, 484-A. See also E. P. Appl. 3321, 9963, 1917, 12085, 1918, abst. J. S. C. I. 1917, **36**, 28; 1918, **37**, 449-A.

11. E. P. Appl. 11077, 1919, abst. J. S. C. I. 1919, **38**, 344-A. See W. Smith, Ann. Rept. Natl. Advisory Comm. for Aeronautics, 1918, 410.

12. U. S. P. 1247610, 1917; 1310841, 1919, E. P. 122677, 1918; abst. J. S. C. I. 1918, **37**, 66-A.

13. E. P. 128690, 128691, 131611, 1918; abst. J. S. C. I. 1919, **38**, 678-A.

H. Gardner,¹ J. Grolea and J. Weyler,² A. Hamilton,³ J. Mandelberg,⁴ A. Mond,⁵ Nicholson,⁶ G. Perrott and A. Plumb,⁷ S. von Petroczy,⁸ Robbins,⁹ E. Robinson,¹⁰ Rogers, Welch & Co.,¹¹ W. Smith,¹² Soc. Industrielle des Telephones,¹³ Gow and St. Armande,¹⁴ D. Sutherland,¹⁵ R. Wheatley,¹⁶ and M. Deschens.¹⁷

Of cognate interest in this connection are the investigations on aeroplane and balloon fabrics as published by E. Walen,¹⁸ J. McKechnie,¹⁹ J. Tuttle,²⁰ Soc. Nauton Freres et de Marsac

- 1920, **39**, 13-A. E. P. App. 22265, 1919, abst. J. S. C. I. 1919, **38**, 391 A. I. Clement and C. Riviere, *Chim. et Ind.* 1920, **3**, 410. J. S. C. I. 1920, **39**, 481-A.
14. U. S. P. 1316782, 1316783, 1316784, 1919, abst. C. A. 1919, **13**, 3011. For an alcohol-insoluble gutta percha substitute from cellulose acetate, see O. Skaller, D. R. P. 347145, 1918, abst. J. S. C. I. 1920, **39**, 445 A.
1. Educational Bur. Paint Mfrs. Assoc. 1919, Circ. 65, abst. Drugs, Oils and Paints, 1919, **35**, 48, C. A. 1919, **13**, 2138, J. S. C. I. 1919, **38**, 545 A.
2. E. P. 123712, abst. J. S. C. I. 1919, **38**, 610 A.
3. Mo. Rev. Bur. Labor Statistics, 1918, **6**, 289, abst. C. A. 1918, **12**, 869.
4. U. S. P. 1302064, 1302065, 1919, E. P. 124494, 124495, 1916, abst. C. A. 1919, **13**, 1936, J. S. C. I. 1919, **38**, 460 A.
5. E. P. 129035, 131940, 1918, abst. J. S. C. I. 1919, **38**, 759 A.
6. E. P. App. 18373, 1918, abst. J. S. C. I. 1918, **37**, 722 A.
7. J. Ind. Eng. Chem. 1919, **11**, 438, abst. J. S. C. I. 1919, **38**, 408 A.
8. E. P. 12804, 1913. Comp. Gen. de Etabl. Public. Freres, E. P. 475351, 1914, abst. J. S. C. I. 1916, **35**, 73. B. Jellinek, *Aust. P.* 80605, *Chem. Ztg.* 1920, **44**, 429.
9. E. P. Appl. 7111, 1918, abst. J. S. C. I. 1918, **27**, 250 A. P. Sci. U. S. P. 1342601, 1342603, 1920, C. A. 1920, **14**, 2418.
10. U. S. P. 1310844, 1919, abst. C. A. 1919, **13**, 2443. J. Larvis, U. S. P. 1343135, 1920, C. A. 1920, **14**, 2418.
11. E. P. Appl. 634, 1918, abst. J. S. C. I. 1918, **37**, 44 A.
12. *Chem. Trade J.* 1918, **63**, 44, abst. C. A. 1918, **12**, 2151. *Chemische Fabrik v. Heyden A. G.* D. R. P. Ann. C. 26778. *Kunst.* 1919, **9**, 182.
13. E. P. 260945, 1912.
14. E. P. App. 2141, 1957, 1958, 1918, abst. J. S. C. I. 1918, **37**, 44 A.
- 194-A. For data on cellulose acetate analysis, see G. Barr and E. Burchinshaw, C. A. 1920, **14**, 837.
15. U. S. P. 1320290, 1920, E. P. 131082, 1918, abst. C. A. 1920, **14**, 131; J. S. C. I. 1919, **38**, 834 A, 954 A. The cellulose acetate plastic of W. Bonner is described in U. S. P. 1163457, 1916.
16. E. P. 112483, 1917, abst. C. A. 1918, **12**, 1002, J. S. C. I. 1918, **37**, 120-A. See also E. P. 105157, abst. J. S. C. I. 1917, **36**, 544. W. Sachs, D. R. Ann. S. 19017, 1918. A. Fuchs, *Chim. et Ind.* 1920, **3**, 167, abst. J. S. C. I. 1920, **39**, 292 A.
17. *Rev. prod. chim.* 1920, **23**, 177, *Chim. Ind.* 1920, **3**, 701.
18. J. Amer. Soc. Mech. Eng. 1918, **40**, 933, abst. C. A. 1919, **13**, 296.
- 3rd. App. Rept. Nat. Advisory Comm. for Aeronautics 1918, 466, abst. C. A. 1919, **13**, 1394. For structure of airplane fabrics, see E. Walen, Nat. Advisory Com. for Aeronautics, Rept. No. 36, 1920, p. 44, abst. C. A. 1920, **14**, 1445. H. Gardner, *Paint Mfrs. Assoc. of U. S.*, Cir. 91 of 1920, C. A. 1920, **14**, 2092. Cf. P. Bradley, *Can. P.* 197134.
19. U. S. P. 1301955, abst. C. A. 1919, **13**, 1936. J. McKechnie, Ryan

and T. Tesse,¹ Schweizerische Versuchsanstalt für Textilindustrie,² W. Morton,³ D. Milne,⁴ H. Honeywell,⁵ G. Haven,⁶ R. Glazebrook, W. Rouse and A. Johnston,⁷ A. Flatters,⁸ G. Esselen,⁹ F. Cochrane,¹⁰ Bradley,¹¹ and W. Williams and North British Rubber Co.¹²

The British Specifications for cellulose acetate are D-6 of June 1918, and for cellulose acetate dope, D-100, of March 1918.

The preparation of acceptable photographic films in continuous lengths of cellulose acetate, has appeared to be one of the most difficult problems to solve in this field, its satisfactory solution depending upon the discovery and application of cellulose acetate of a chemical body or mixture which will impart the thermoplasticity, which camphor does with the nitrocellulose.

and Vickers, Ltd., E. P. Appl. 7465, 1919, abst. J. S. C. I. 1919, **38**, 238-A. Vickers, Ltd., and J. McKechnie, E. P. 125617, 125636, abst. J. S. C. I. 1919, **38**, 344-A.

20 Third Ann. Rep. Nat. Advisory Comm. Aeronautics, 1917, 463, abst. C. A. 1919, **13**, 1394.

1. E. P. 124763, 124844, 126980, 1916, 131369, 1918; abst. J. S. C. I. 1919, **38**, 272-A, 319-A, 531-A, 759-A, C. A. 1919, **13**, 1771.

2. E. P. 124183, 1918; abst. J. S. C. I. 1919, **38**, 313-A.

3. E. P. 125261, 1919. E. Dammann, F. P. 473126, 1914, E. P. 13872, 1914; J. S. C. I. 1915, **34**, 546, 1916, **35**, 734.

4. Nat. Fire Pro. Assoc. Quart. 1919, 345, abst. C. A. 1919, **13**, 1937.

5. U. S. P. 1281374, abst. C. A. 1919, **13**, 196. For the use of antimony chloride in connection with cellulose ester solutions, for fireproofing, see A. Arant, E. P. 138641, abst. C. A. 1920, **14**, 1879.

6. Proc. Amer. Soc. Testing Materials, 1919, **18**, 380, abst. C. A. 1919, **13**, 908.

7. E. P. 124520, 1916, abst. C. A. 1919, **13**, 1770, J. S. C. I. 1919, **38**, 555-A.

8. E. P. 129456, 1918, abst. C. A. 1919, **13**, 3020, J. S. C. I. 1919, **38**, 558-A. E. P. Appl. 11607, 1918, 16073, 1919, abst. J. S. C. I. 1918, **37**, 449-A; 1919, **38**, 483-A.

9. J. Ind. Eng. Chem. 1918, **10**, 135; abst. C. A. 1918, **12**, 768; J. S. C. I. 1918, **37**, 214-A. The cellulose acetate light transforming reflectors of P. Hewitt, are described in E. P. 16273, 1911; Brit. J. Phot. 1911, **58**, 786.

10. E. P. 125093, 127301, 129712, 1917, 130672, 1918, abst. J. S. C. I. 1919, **38**, 446-A, 558-A, 760-A, 761-A. G. Heyl (E. P. 7880, 1914) impregnates tires with cellulose acetate.

11. E. P. Appl. 17078, 1919; abst. J. S. C. I. 1919, **39**, 517-A. G. Koller, Aust. P. 50580. F. Haight (E. P. 138226, 1919; J. S. C. I. 1920, **39**, 292-A) prepares cellulose acetate paper for use as a dielectric for electrical condensers.

12. E. P. 13689, 13690, 1915, abst. C. A. 1919, **13**, 1652; J. S. C. I. 1919, **38**, 238-A. See also J. S. C. I. 1919, **38**, 144-R, 208-A. W. Lindsay and the Celluloid Co., U. S. P. 1045011, 1912; abst. Chem. Ztg. 1913, **37**, 188. L. Lilienfeld, D. R. P. 259840, F. P. 459072, 1913; and Addn. 16144 thereto Ital. P. 132825, 133188, 1913. Span. P. 55104, Hung. P. Ann. L-3470, 1913. Aust. P. 47237, 1912; 54719, 62863, 1913.

The solution of this problem has been quite closely approached.

The acetylcellulose sheets of C. Waite,¹ E. Zuehl,² L. Lederer,³ H. Cathelineau and A. Fleury,⁴ H. Mork,⁵ H. Danzer,⁶ Balland et Cie,⁷ A. Lumière,⁸ P. Hewitt,⁹ V. Henri,¹⁰ Knoll & Co.,¹¹ Societe Generale des Films and C. Gonon,¹² G. Bonwitt,¹³ B. Borzykowski,¹⁴ H. Dreyfus,¹⁵ G. Chandon de Briailles,¹⁶ Gulbinol Ges.,¹⁷ A. Helbronner and E. Vallee,¹⁸ C. Mijnsen,¹⁹ Compagnie Generale des Etablissements Pathe Freres,²⁰ Societe Anon des Celluloses Planchon,²¹ and The Viscose Development Co., Ltd.,²² show the trend

1. U. S. P. 600241, 1901
2. U. S. P. 720690, 1903; D. R. P. 162239, 1902
3. E. P. 8845, 1900, abst. J. S. C. I. 1900, **28**, 1271; F. P. 402083, 1900; abst. J. S. C. I. 1900, **28**, 1270
4. F. P. 354942, 1905; abst. J. S. C. I. 1905, **24**, 1169. Addition thereto dated June 8, 1905, abst. J. S. C. I. 1905, **24**, 1226; E. P. 12277, 12278, 1905, abst. J. S. C. I. 1906, **25**, 327; D. R. P. 185240, 1906, abst. Chem. Zentr. 1907, **78**, 11, 1037; Zts. ang. Chem. 1907, **20**, 2177; D. R. P. 185241, 1906, abst. Chem. Zentr. 1907, **78**, 11, 1819; E. P. 11625, 1900, abst. J. S. C. I. 1900, **28**, 1030; F. P. 402072, 1900, abst. J. S. C. I. 1900, **28**, 1221
5. U. S. P. 1061771, 1913, abst. Kunst. 1913, **3**, 436; Mon. Sci. 1914, **80**, 23; U. S. P. 1107222, 1914, abst. J. S. C. I. 1914, **33**, 953; C. A. 1914, **8**, 3371; Cf. U. S. P. 1009116, 1911, U. S. P. 1035108, 1912
6. E. P. 3603, 1910, abst. J. S. C. I. 1910, **29**, 978; F. P. 410725, 1909, First Add. dated Mar. 18, 1910, to F. P. 410725, abst. J. S. C. I. 1911, **30**, 925; E. P. 14407, 1909, abst. J. S. C. I. 1909, **28**, 1327; See also U. S. P. 988081, 1911; D. R. Ann. 25533, 1911; F. P. 401228, 1908, abst. J. S. C. I. 1909, **27**, 1064
7. Balland et Cie, F. P. 457925, 1913, abst. J. S. C. I. 1913, **32**, 1033
8. F. P. 401228, 1908, abst. J. S. C. I. 1909, **28**, 1064; E. P. 3606, 1910, abst. J. S. C. I. 1910, **29**, 978; F. P. 410725, 1909
9. D. R. P. 254083, 1911, abst. C. A. 1911, **8**, 1065
10. Compt. rend. 1912, **155**, 315
11. E. P. 3559, 1910, abst. J. S. C. I. 1910, **29**, 1082; F. P. 412503, 1910, abst. J. S. C. I. 1910, **29**, 1038; Aust. P. 41831, 1907; Phot. Ind. 1912, 500; Eder. Jahr. 1911, 498
12. F. P. 388755, 1908, abst. J. S. C. I. 1908, **27**, 959; See J. Chabuet, E. P. 14525, 1899
13. D. R. P. 237151, 1908, abst. J. S. C. I. 1911, **30**, 1232; Zts. ang. Chem. 1911, **24**, 1838; Chem. Zentr. 1911, **82**, 11, 500; Wsg. Jah. 1911, **57**, 11, 506; See also Bonwit, Kunst. 1913, **3**, 456; For the preparation of elastic masses of nitro- or acetyl cellulose, see D. R. Ann. B. 50757 of 1908
14. E. P. 21719, 1910, 4601, 12090, 1913, abst. J. S. C. I. 1911, **30**, 1213, 1914, **33**, 349; Kunst. 1912, **2**, 76; F. P. 420555, 1910, 454692, 1913, abst. J. S. C. I. 1911, **30**, 363, 1913, **32**, 865; Swiss P. 54146, 1911
15. E. P. 20979, 1911, 114304, 1918, 132283, 1919, abst. C. A. 1918, **12**, 1512
16. F. P. 386845, 1907, abst. J. S. C. I. 1908, **27**, 834
17. D. R. P. 283746, 1913, abst. C. A. 1915, **9**, 2442
18. Swiss P. 42572, 1908
19. Phot. Ind. 1911, 28, abst. Eder. Jahr. 1911, 526
20. F. P. 475351, 1914; abst. J. S. C. I. 1916, **35**, 73
21. E. P. 7442, 1910
22. Aust. P. 66165, abst. Kunst. 1915, **5**, 82

of development in the direction of acetate sheet formation.

F. Paschke¹ forms compound splinterless glass by cementing two sheets of glass by means of cellulose acetate; while the Deut. Gasglühlicht A. G.² has found that glass coated with acetyl cellulose, by a short immersion in feebly alkaline, or better in aqueous methyl alcohol solutions, is not obscured by condensed moisture.

In the formation of artificial filaments,³ may be cited the mechanical and chemical processes of H. Mork, A. Little and W. Walker,⁴ L. Lederer,⁵ F. Bayer & Co.,⁶ Knoll & Co.,⁷ Fürst Guido

1. E. P. 15880, 1913; abst. C. A. 1915, **9**, 137.
2. D. R. P. 297955; abst. Chem. Zentr. 1920, **91**, II, 651; J. S. C. I. 1920, **39**, 519-A.
3. For general articles on cellulose acetate filaments, see R. Bernard, Mon. Sci. 1905, 321; Zts. ang. Chem. 1906, **19**, 86; Jahr. Chem. 1905-8, II, 989; F. Beltzer, Mon. Sci. 1910, (4), **24**, 145, 162; abst. Chem. Abst. 1910, **4**, 1238; Chem. Zentr. 1910, **81**, II, 509; H. Chauvet, Bull. Technologique, 1912, No. 5, 679; A. Colin, Rev. gén. Chim. 1909, **12**, 49-62; abst. Chem. Zentr. 1909, **80**, I, 1121; Zts. ang. Chem. 1909, **22**, 943, 1620; A. Colin, Rev. gén. chim. 1909, **12**, 95-95; abst. Zts. ang. Chem. 1909, **22**, 1620; Rev. gén. chim. pure appl. 1909, **12**, 95; W. Dohrt, Zts. ang. Chem. 1907, **20**, 743-746; abst. C. A. 1907, **1**, 1359, 2178; Bull. Soc. Chim. 1907, (4), **2**, 908; Jahr. Chem. 1905-8, II, 983; Chem. Zentr. 1907, **78**, I, 1736; W. Dreaper, J. S. C. I. 1909, **28**, 1297-1303; abst. Bull. Soc. Chim. 1910, (4), **8**, 524; C. A. 1909, **3**, 490; Chem. Zentr. 1910, **81**, I, 1396; Zts. ang. Chem. 1910, **23**, 959; W. Dreaper and J. Davis, Jour. Soc. Dyers, 1909, **24**, 294; abst. C. A. 1909, **3**, 490; J. S. C. I. 1909, **28**, 19; E. Fischer, Kunst. 1912, **2**, 21-24, 48-52, 64-69; A. Herzog, Chem. Ztg. 1910, **34**, 347-349; abst. Zts. ang. Chem. 1910, **23**, 1390; J. S. C. I. 1910, **29**, 585; Jahr. Chem. 1910, **63**, II, 428; C. A. 1910, **4**, 2371; H. Lebach, Chem. Ztg. 1911, **35**, 107; R. Loewenthal, Chem. Ztg. 1909, **33**, 753-755, 770-772; abst. Bull. Soc. Chim. 1910, (4), **8**, 59; W. Mann, Chimiste, **3**, 41-43, 43-45; abst. C. A. 1912, **6**, 1849; W. Massot, Zts. ang. Chem. 1905, **18**, 1080-1088; abst. Wag. Jahr. 1905, II, 397; C. A. 1907, **1**, 2193; Zts. ang. Chem. 1908, **21**, 340-354; abst. Bull. Soc. Chim. 1908, (4), 635; Zts. ang. Chem. 1907, **20**, 437-444, 484-490; abst. Bull. Soc. Chim. 1907, (4), **2**, 903; Zts. ang. Chem. 1909, **22**, 241-252, 299-305; abst. Bull. Soc. Chim. 1909, (4), **6**, 556; Marsden, Farb. Ztg. 1906, **42**, 172; E. Thiele, Chem. Ztg. 1904, **28**, 715-721; See also Wag. Jahr. 1897, **43**, 730-731, 1899, **45**, 1064, **47**, II, 611, 1904, **50**, II, 391, 1910, **56**, II, 434. In "Encyclopädie der Technischen Chemie," vol. 4, pp. 114-130, is a general article on acetylcellulose by A. Eichengrün; F. Marsden, Jour. Soc. Dyers Col. 1905, **21**, 102, 192; A. Eichengrün, Kunst. 1911, **1**, 152; Zts. ang. Chem. 1908, 1730; abst. Wag. Jahr. 1908, **54**, II, 500; L. Clement and C. Riviere, Rev. chim. ind. **22**, 215-20; abst. C. A. 1911, **5**, 3908; W. Walker, Jour. Frank. Inst. 1907, **144**, 131-140; abst. C. A. 1908, **2**, 318, 2619; F. Beltzer, 8th. Intl. Cong. Appl. Chem. 1912, **8**, 13; Mon. Sci. 1911, (5), **74**, 641.
4. W. Massot, Farb. Ztg. 1909, **18**, 146, 166, 182; Zts. ang. Chem. 1909, **22**, 241, 252, 299, 305; Chem. Zentr. 1909, **80**, I, 801; Bull. Soc. Chim. 1909, (4), **6**, 555; A. Herzog, Zts. ang. Chem. 1906, **19**, 1899; Oest. Chem. Ztg. 1906, **9**, 166; Jahr. Chem. 1905-8, II, 4624; Chem. Zentr. 1906, **77**, II, 372; C. Hassack, Oest. Chem. Ztg. 1900, **3**, 235, 267, 297; Chem. Zentr. 1900, **71**, I, 4312; II, 226, 2359; Saget and Suevern, Bull. Soc. d'Encouragement, 1906, 540.
5. U. S. P. 712200, 1902; abst. Mon. Sci. 1903, (4), **63**, 165. The material used was preferably prepared according to U. S. P. 709922, 1302;

Donnersmarcksche Kunstseide und Acetatwerke,¹ Chemische Fabrik von Heyden,² H. Dreyfus and L. Schneeberger,³ K. Hof,

E. P. 20660, 1902; F. P. 324862, 1902, abst. J. S. C. I. 1902, **21**, 1315, 1903, **22**, 646, 1011. Mork, Walker and Little, U. S. P. 792149, 1905, abst. J. S. C. I. 1905, **24**, 799; Mon. Sci. 1906, (4), **64**, 22.

5. E. P. 7341, 1903, abst. J. S. C. I. 1904, **23**, 501. F. P. 330714, 1903; abst. J. S. C. I. 1903, **22**, 1100; Mon. Sci. 1904, (4), **60**, 66. E. P. 26502, 1906; abst. J. S. C. I. 1907, **26**, 681. F. P. 371357, 1906, abst. J. S. C. I. 1907, **26**, 340; Mon. Sci. 1908, (4), **68**, 79. Belg. P. 195839, 1906.

6. E. P. 28733, 1904, abst. J. S. C. I. 1905, **24**, 1299. F. P. 330412, 1904, abst. J. S. C. I. 1905, **25**, 262; Mon. Sci. 1906, (4), **64**, 169. Patente recommends to use for this process, cellulose acetate obtained according to

E. P. 21628, 1901; F. P. 317007, 1901. D. R. P. 210188, 1900, abst. Zts. ang. Chem. 1911, **24**, 2336; Chem. Zentr. 1911, **82**, 11, 1563. F. P. 115027, 1910,

abst. J. S. C. I. 1910, **29**, 1373; Mon. Sci. 1913, **73**, 20. E. P. 11354, 1893, 1909, 13100, 1910. U. S. P. 1031616, 1912. F. P. 108350, 1910, and First Addition No. 12469, and Second Addition of June 11, 1910, thereto. Aust. P. 296, 4642, June 21, 1909. Abst. J. S. C. I. 1910, **29**, 533, 575, 621, 752, 1299, 1371, 1912, **31**, 770. See Vieweg, "Manufacture of Acetate Silks,"

E. P. 15544, 1914, D. R. Ann. June 28, 1913. D. R. P. 243068, 1909, F. P. 408370, 1909, abst. J. S. C. I. 1910, **29**, 621. E. P. 18193, 1909, abst. J. S. C. I. 1910, **29**, 575. U. S. P. 1031616, 1912, abst. J. S. C. I. 1912, **31**, 770. Chem.

Abst. 1912, **6**, 2687. Belg. P. 220225, 1909. Swiss P. 18975. Aust. P. 296, 4642, 1909. The U. S. Patent was taken out in the name of P. Bernath,

E. Damm and O. Stephani. The metal powder or pigments are said not to penetrate the core of the thread to any appreciable extent, but remain largely as a superficial layer of distinct metallic particles or flakes, each encased by

and incorporated with the acetyllulose. For "Manufacture of Artificial Silk Threads from Cellulose Esters," by F. Duclaux, see Belg. P. 245332, 1912.

For articles on "Bavkogan," see Prom. 1911, **7**, 9. Kogelkroner, 1911, No. 16. S. Feitler, "Das Celluloid und Seine Ersatzstoffe," 1912, 43-45.

Prefably prepared according to U. S. P. 790565, 1905; F. P. 317007, 1901; D. R. P. 150825, 159521, 1901; E. P. 21628, 1901. For me-

chanical appliance to coat yarns with cellulose acetate, see Bayer & Co., D. R. P. 227238, 1909. Prefably prepared according to E. P. 24967, 1906; U. S. P. 838350, 1906; F. P. 371147, 1906. E. P. 18193, 1909, abst. J. S. C. I.

1910, **29**, 575. First Addition No. 12469, 1910, to E. P. 408370, 1909, abst. J. S. C. I. 1910, **29**, 1299. D. R. P. 248916, 1909, being Addition to D. R. P.

150825, 1904, abst. Zts. ang. Chem. 1904, **17**, 1124, of A. Forster, in which nitro-cellulose solution containing a small amount of water is used for the

same purpose as above. A. P. 13100, 1910, abst. J. S. C. I. 1911, **30**, 533. Second Addition dated June 11, 1910, to E. P. 408370, 1909, abst. J. S. C. I.

1910, **29**, 1371. Belg. P. 181504, 1904.

7. E. P. 2026, 1907, abst. J. S. C. I. 1908, **27**, 353. F. P. 369123, 1096, abst. J. S. C. I. 1907, **26**, 91; Mon. Sci. 1908, (4), **68**, 28. D. R. P. 180666, 1905, abst. Zts. ang. Chem. 1907, **20**, 1786; Mon. Sci. 1909, (4), **70**,

77. Jahr. Chem. 1905 8, II, 982. D. R. P. 180667, 1905, being addition to D. R. P. 180666, abst. Zts. ang. Chem. 1907, **20**, 1786; Mon. Sci. 1909, (4), **70**, 77; Jahr. Chem. 1905 8, II, 982. D. R. P. 286173, 1915, abst. C. A. 1916,

10, 1701; J. S. C. I. 1915, **34**, 1138; Chem. Zentr. 1915, **86**, 11, 450.

10. U. S. P. 922340, 1909, abst. J. S. C. I. 1909, **28**, 671. F. P. 400652, 1909, abst. J. S. C. I. 1909, **28**, 1061; Mon. Sci. 1910, (4), **73**, 165. D. R. P. 237718, 1907; Zts. ang. Chem. 1911, **24**, 1988; Chem. Zentr. 1911, **82**, 11,

922. It. P. 303-136-101262, 1909. For use of lactic acid as solvent see D. R. P. 239701, 1910; abst. C. A. 1912, **6**, 2169.

12. Chemische Fabrik von Heyden E. P. 3973, 1911, abst. J. S. C. I.

mann,¹ L. Lilienfeld,² F. Sammet,³ A. Stiebel,⁴ A. Herzog,⁵ Vereinigte Kunstseidenfabriken,⁶ W. Massot,⁷ C. Hassack,⁸ Saget and Suevern,⁹ Compagnie Francaise des Applications de la Cellulose,¹⁰ W. Beatty,¹¹ E. Dammann,¹² G. Heyl,¹³ A. Kramer,¹⁴ W. Suida,¹⁵

1911, **30**, 156; C. A. 1912, **6**, 2172. F. P. 426436, 1911; abst. J. S. C. I. 1911, **30**, 950. Aust. Appl. A-327, Jan. 12, 1911. Belg. P. 232475, 1911. D. R. Anm. C-19868, 1910; C-23158, 1913; C-23487, 1913. In their D. R. P. 273029, 1910, addition to D. R. P. 269193; abst. C. A. 1914, **8**, 2251, 2806, in the manufacture of cellulose acetates the cotton is first thoroughly dried. F. P. 425436, 1911; Swiss P. 55344, 1911.

3. F. P. 413787, 1910; abst. J. S. C. I. 1910, **29**, 1101; Mon. Sci. 1911, (5), **74**, 155.

1. D. R. P. 227198, 1909; abst. J. S. C. I. 1910, **29**, 1300; Chem. Zts. 1910, **3**, 2102; Chem. Zentr. 1910, **81**, I, 1349; Jahr. Chem. 1911, **63**, II, 429. See Zeits. Farb. Text ind. 1905, **4**, 383; 1907, **6**, 2; Schwalbe, Ber. 1908, **40**, 1347, 4523. In the example given, 300 cc. concentrated phosphoric acid mixed with 300 cc. glacial acetic acid in which 20-25 gm. cellulose is dissolved at the ordinary temperature.

2. U. S. P. 904269, 1908; abst. J. S. C. I. 1908, **27**, 1202. E. P. 4597, 1906; abst. J. S. C. I. 1907, **26**, 146. D. R. P. 175664, 1903; abst. Zts. ang. Chem. 1907, **20**, 461. U. S. P. 888516, 1908; abst. J. S. C. I. 1908, **27**, 683. E. P. 592, 1907; abst. J. S. C. I. 1908, **27**, 73. D. R. P. 169782, 1904. D. R. P. 182773, 1904; abst. Zts. ang. Chem. 1907, **20**, 2090. Wag. Jahr. 1907, **53**, II, 463. E. P. 14483, 1903. U. S. P. 904269, 1908; abst. J. S. C. I. 1908, **27**, 1202. E. P. 4597, 1906; abst. J. S. C. I. 1907, **26**, 146. D. R. P. 175664, 1903; abst. Zts. ang. Chem. 1907, **20**, 461. U. S. P. 888516, 1908; abst. J. S. C. I. 1908, **27**, 683. E. P. 592, 1907; abst. J. S. C. I. 1908, **27**, 73. D. R. P. 169782, 1904. D. R. P. 182773, 1904; abst. Zts. ang. Chem. 1907, **20**, 2090. E. P. 14483, 1903; abst. J. S. C. I. 1903, **22**, 1345. U. S. P. 904269, E. P. 4597, 1906, D. R. P. 175664 are the same. U. S. P. 888516, E. P. 592, 1907, are the same. To increase the flexibility of the acetate-mica combination, ethyl phthalate (U. S. P. 888516) or ethyl palmitate or acetylaliphatic esters (U. S. P. 904269) may be added. See Lehne's Farb. Ztg. 1893, 190.

3. D. R. Anm. S-37509, 1912; abst. Zts. ang. Chem. 1913, **26**, 700.

4. D. R. P. 231030, and Addition thereto, D. R. P. 267370, 1913; abst. C. A. 1912, **6**, 1717; 1914, **8**, 1711.

5. Kunst. 1912, **2**, 104-109; abst. Chem. Abst. 1912, **6**, 2320. Zts. ang. Chem. 1906, **19**, 1899; Oest. Chem. Ztg. 1906, **9**, 166; Jahr. Chem. 1905-8, II, 4624; Chem. Centr. 1906, **77**, II, 372.

6. D. R. P. 181784, 1905.

7. Farb. Ztg. 1909, **18**, 146, 166, 182; abst. Zts. ang. Chem. 1909, **22**, 241, 252, 299, 305; Chem. Zentr. 1909, **80**, I, 801; Bull. Soc. Chim. 1909, (4), **6**, 555.

8. See C. Hassack, Oest. Chem. Ztg. 1900, **3**, 235, 267, 297; abst. Chem. Centr. 1900, **71**, I, 1312; II, 226, 359; Zts. ang. Chem. 1900, **13**, 89.

9. Bull. Soc. d'Encouragement, 1906, 540.

10. Compagnie Francaise des Applications de la Cellulose, F. P. 411599, 1910; abst. J. S. C. I. 1911, **30**, 19. The sthenosage of artificial filaments with aldehydes is not as applicable to acetate filaments.

11. U. S. P. 1156969, 1915; abst. C. A. 1915, **9**, 3358; J. S. C. I. 1915, **34**, 1204.

12. E. P. 13672, 1914; F. P. 473126, 1914; D. R. P. 287073, 1913; abst. C. A. 1916, **10**, 2047; J. S. C. I. 1915, **34**, 646.

13. E. P. 8154, 1914. See E. P. 23873, 1910.

14. Monatschr. Textilind. 1918, **33**, 81; abst. J. S. C. I. 1919, **38**, 281-A;

and W. Vieweg,¹ upon which the present industry has been based.

The dyeing of cellulose acetate filaments has proven no easy problem. Contributions to this phase of cellulose ester technology have been made by Aktien Ges. f. Anilin Fabrikation,² Knoll & Co.,³ E. Knoevenagel,⁴ Fürst Guido Donnersmarck'sche Kunstseide und Acetatwerke,⁵ H. Mork,⁶ E. Friedmann,⁷ B. Chem. Zentr. 1919, **90**, p. 118.

15. Monatsh. Chem. 1905, **26**, 113, abst. J. S. C. I. 1905, **24**, 543, J. C. S. 1905, **88**, 457.

1. F. P. 474163, 1913, abst. J. S. C. I. 1915, **34**, 711.

2. Aktien-Gesellschaft f. Anilin Fabrikation, D. R. P. 193135, 1905, abst. Chem. Zts. 1908, **7**, 630, Wag. Jahr. 1907, **53**, 11, 433, Zts. ang. Chem. 1903, **21**, 1266, Mon. Sci. 1910, (4), **73**, 158, E. P. 1939, 1906, abst. J. S. C. I. 1906, **25**, 1216, D. P. 362721, 1909, abst. J. S. C. I. 1906, **25**, 692.

3. U. S. P. 961241, 979966, 1910, 981574, 1002108, 1911, abs. J. S. C. I. 1910, **29**, 876, 1911, **30**, 126, 206, 1157, Mon. Sci. 1910, (4), **73**, 135, E. P. 24284, 1907, abst. J. S. C. I. 1908, **27**, 1150, Mon. Sci. 1911, (5), **74**, 92, E. P. 7743, 1909, abst. J. S. C. I. 1910, **29**, 209, E. P. 383636, 1907, and First Addition thereto dated Apr. 5, 1909, abst. J. S. C. I. 1908, **27**, 332, 1909, **28**, 1199, D. R. P. 198008, 1907, abst. Chem. Zts. 1908, **7**, 865, Zts. ang. Chem. 1908, **21**, 1471, Wag. Jahr. 1908, **54**, 11, 409, Bull. Soc. Chim. 1909, (4), **6**, 557, D. R. P. 199559, 1907, abst. Chem. Zentr. 1908, **79**, 11, 271, Zts. ang. Chem. 1908, **21**, 1810, Bull. Soc. Chim. 1909, (4), **6**, 557, D. R. P. 234028, 1908, abst. Zts. ang. Chem. 1911, **24**, 1151. The relation of the important series of patents to each other is as follows: E. P. 21284, 1907, F. P. 383636, 1907, U. S. P. 961241, 1910, U. S. P. 979966, 1910, U. S. P. 1002108, 1911, D. R. P. 198008, 1907, 199559, 1907, are the same; D. R. P. 199559, 1907, U. S. P. 961241, 1910, are the same; E. P. 7743, 1909, U. S. P. 981574, 1911, First Add. F. P. 383636, 1909, D. R. P. 234028, are the same.

(1) U. S. P. 961241, D. R. P. 199559, cover swelling the cellulose acetate to increase receptiveness to dyestuff.

(2) U. S. P. 979966 covers impregnation with *b*-naphthol and *p*-amino phenol.

(3) U. S. P. 1002108 covers impregnation with *p*-nitranilin, ammoazo benzene, α -naphthylamin, β -naphthylamin, benzidin, diamidin, *m*-phenylene diamine, *p*-aminophenol, and naphthionic acid.

(4) D. R. P. 198008 covers (2) and (3) above.

(5) E. P. 24284, 1907, F. P. 383636, each cover (1), (2), (3) above; E. P. 7743, 1909, First Addition to F. P. 383636, D. R. P. 234028 and U. S. P. 981574 cover treating acetylcellulose with hydrochloric acid to enhance its capacity for dye absorption; D. R. P. 234028 cites D. R. P. 199559, 1908, 198008, E. P. 7743, 1909, cites E. P. 21284, 1907; U. S. P. 961241 cites D. R. P. 193135. The United States patents are taken out in the name of E. Knoevenagel.

4. U. S. P. 961241, 1910, F. P. 383636, 1907. Methylene blue, mala chite green, fuchsin and saffranin are particularly recommended among the basic dyestuffs, although auramine, rhoduline, heliotrope, methyl violet, induline and the basic nigrosines are satisfactory.

U. S. P. 979966. Cellulose acetate filaments impregnated for half an hour at a temperature of a water bath in 0.5% solution of *b*-naphthol and rinsed with water give nitraniline red when coupled with 1.5% *p*-nitraniline hydrochloride solution which has been diazotized in the usual manner with acidified sodium nitrite solution. Or, by treating the filaments with α -naphthylamine instead of *p*-nitraniline hydrochloride, α -naphthylamine bor deaux is produced.

5. Fürst Guido Donnersmarck'sche Kunstseide und Acetatwerke,

Barzykowski,¹ L. Lederer,² A. Wagner,³ C. Cross and E. Bevan,⁴ and F. Bayer & Co.⁵

Among the many other applications in fields of usefulness to which it has been proposed to apply the acetylated celluloses, may be included the inventions and ideas of J. Daly,⁶ A. Zimmer,⁷ H. Peters,⁸ E. Roggenkaemper,⁹ M. Kruemmeling,¹⁰ Leduc, Heitz &

D. R. P. 228867, 1907; abst. J. S. C. I. 1911, **30**, 21; Chem. Zts. 1910, **9**, 2138; Zts. ang. Chem. 1910, **23**, 2398; Chem. Ztg. Rep. 1910, **34**, 638. D. R. P. 197965, 219848.

6. E. P. 20672, 1910; F. P. 416752, 1910, abst. J. S. C. I. 1910, **29**, 1371; 1911, **30**, 354.

7. U. S. P. 994738, 1911, abst. J. S. C. I. 1911, **30**, 888; U. S. P. issued to E. Friedmann. E. P. 1556, 1911; abst. J. S. C. I. 1911, **30**, 1236, 1309. F. P. 427445, 1911; abst. J. S. C. I. 1911, **30**, 1051, D. K. P. 237210, 1910; abst. Zts. ang. Chem. 1911, **24**, 1837; Wag. Jahr. 1911, **57**, II, 468; Chem. Zentr. 1911, **82**, II, 497. Belg. P. 233786, 1911. Aust. P. Appl. A-2376-11, Mar. 16, 1911; abst. Chem. Ztg. 1912, **36**, 252.

8. E. P. 12995, 1912, abst. C. A. 1913, **7**, 3840; U. S. P. 1041587, 1912; abst. Mon. Sci. 1913, **79**, 110. Belg. P. 246562, 1912. D. R. Ann. B. 63482, 1911. F. P. 441588; abst. Kunst. 1913, **3**, 15. See also E. P. 22826, 1913. Ital. P. 386, 167, 125696; abst. Chem. Ztg. 1913, **37**, 272. U. S. P. 1041587, 1912.

9. E. P. 11625, 1909; abst. J. S. C. I. 1909, **28**, 1030. F. P. 402072, 1909; abst. J. S. C. I. 1909, **28**, 1221. D. R. P. 240751, 1908; abst. Chem. Abst. 1912, **6**, 2179; Kunst. 1912, **2**, 215; Chem. Zentr. 1911, **82**, II, 1843. D. R. P. 248559, 1909, abst. Kunst. 1912, **2**, 296. See also Donnersmarck, D. R. P. Ann. Sn. D. 24553, Jan. 18, 1911, Method of Dyeing Formed Cellulose Acetate. See "Dyeing Artificial Silk of Cellulose Acetate," Text. Col. 1909, **31**, 264; 1910, **32**, 15.

10. D. R. P. 152217, 1901. Compare A. Sansone, "Dyeing Acetate Silk," D. R. Ann. S-31390, 1910. D. R. P. 152432, 1901; abst. Zts. ang. Chem. 1904, **17**, 1252; Wag. Jahr. 1904, II, 417.

4. Prize method in Jour. Soc. Dyers. 1908, **24**, 189; abst. J. S. C. I. 1908, **27**, 802; Zts. ang. Chem. 1908, **21**, 2189; C. A. 1908, **2**, 2996. Process protected by following patents issued to C. Cross and J. Briggs. U. S. P. 920828, 1909; abst. J. S. C. I. 1909, **28**, 623. E. P. 5016, 1907; abst. J. S. C. I. 1908, **27**, 330; Mon. Sci. 1911, **74**, (5), 92; Farb. Ztg. **19**, 142; Bull. Soc. Chim. 1909, (4), **6**, 557. F. P. 383064, 1907; abst. J. S. C. I. 1908, **27**, 330. D. R. P. 224330, 1907; abst. Chem. Zts. 1910, **9**, 2105; Zts. ang. Chem. 1910, **23**, 2056; Chem. Zentr. 1910, **81**, II, 515; Chem. Tech. Rep. 1910, **59**, I, 434; Jahr. Chem. 1910, **63**, I, 426.

5. E. P. Appl. 1556, 1911; J. S. C. I. 1911, **30**, 162. See also D. R. P. Ann. 24553; abst. Chem. Ztg. 1913, **37**, 104.

6. U. S. P. 604946, 1902; abst. J. S. C. I. 1902, **21**, 474. E. P. 5348, 1902; abst. J. S. C. I. 1902, **21**, 912. According to an alternate method, the lace is stretched in a frame and brushed over with lacquer, silver sulfide being subsequently precipitated upon it by successive treatment with solutions of silver nitrate and a soluble sulfide. See also J. Daly, U. S. P. 707306, 1902; abst. J. S. C. I. 1902, **21**, 1186.

7. E. P. 12406, 1910; abst. J. S. C. I. 1911, **30**, 206; D. R. P. 242786, 1910; abst. C. A. 1912, **6**, 2182; Wag. Jahr. 1912, **58**, II, 509. In the apparently corresponding U. S. P. 1025731, 1912; abst. C. A. 1912, **6**, 1994, nitrocellulose is claimed, specified and described to be used the same as in the English and German patents above cited for the use of cellulose acetate.

8. E. P. 870, 1910; abst. J. S. C. I. 1911, **30**, 206; F. P. 420127, 1910;

Co.,¹ A. Douque,² E. Girzik,³ The Viscose Development Co.,⁴ L. Lilienfeld,⁵ Raison-Sociale Siebert Freres,⁶ W. Balser,⁷ Societe Anon. Celluloses Planchon,⁸ A. Eichengruen,⁹ F. Bayer & Co.,¹⁰

abst. Mon. Sci. 1913, **78**, 21, J. S. C. I. 1911, **30**, 280. See also H. Peters, E. P. 14293, 1910; abst. J. S. C. I. 1911, **30**, 1171.

9. Madam Roggenkaemper, nee E. Vahlkamp, E. P. 107932, 1909, abst. J. S. C. I. 1910, **29**, 623.

10. E. P. 10578, 1909. Cites E. P. 11183, 1903, 1957, 26502, 1906. For process of waterproofing linen with nitrocellulose, see W. Brueckner, D. R. P. 238361, 241781, 1909, abst. C. A. 1911, **5**, 2900, 1912, **6**, 2180, J. S. C. I. 1912, **31**, 227.

1. E. P. 146627, 1912, abst. Kunst. 1913, **3**, 175, E. P. 6798, 1912, abst. J. S. C. I. 1912, **31**, 1016. E. P. 426788, 1911, abst. J. S. C. I. 1911, **30**, 1267; C. A. 1912, **6**, 2186, Oil, Paint and Drug Review, Apr. 24, 1912, Chem. Tech. Rep. 1912, **36**, 63, Belg. P. 226396. Especially suitable for the coating of aeroplane wings and called by them E-maille (Kunst. 1912, **2**, 419).

2. E. P. 17449, 1909, abst. J. S. C. I. 1910, **29**, 1007. E. P. 403761, 1909; abst. J. S. C. I. 1910, **29**, 19. D. R. P. 286120, abst. Chem. Zentr. 1915, **86**, II, 447.

3. Aust. P. 3034, 1913, abst. C. A. 1914, **8**, 2229.

4. D. R. P. 270314, 1911, abst. C. A. 1914, **8**, 2251, 2252. Swiss P. 50152, 1911.

5. U. S. P. 1090730, 1914, abst. C. A. 1914, **8**, 1680. E. P. 28210, 1912; abst. C. A. 1914, **8**, 1886. Lilienfeld (E. P. 23892, 1901, abst. J. S. C. I. 1902, **21**, 771. E. P. 316229, abst. J. S. C. I. 1902, **21**, 704) obtains impres-

sions with pigments and powdered metals which are said to be perfectly resistant and pliable, by the use of (1) metallic salts or fatty acids, especially the oleates, stearates and palmitates of aluminum and zinc, and metallic resmates, dissolved in volatile or non-volatile oils, benzene, carbon bisulfide, or acetone (2) acid derivatives of albumin, e. g., acetyl albumin (obtained by treating albumin with acetic anhydride and a condensing agent or with acetyl chloride, dissolved in acetone or ethyl acetate, and (3) India rubber or gutta percha decomposed by heating for about 5 hours at 240°-300° with a drying oil. E. P. 26928, 1910. For dental uses of cellulose acetate see P. Hartter, D. R. P. 206272, abst. Kunst. 1919, **9**, 187.

6. E. P. 396467, 1908, abst. J. S. C. I. 1909, **28**, 598.

7. D. R. P. 202267, 1906, abst. C. A. 1909, **3**, 192, Chem. Zentr. 1908, **79**, II, 1399.

8. E. P. 7442, 1911, abst. J. S. C. I. 1912, **31**, 224. See also E. P. 4959, 1910, abst. J. S. C. I. 1911, **30**, 69. See Aktien-Ges. f. Anilin-fabr., E. P. 21015; 1913, F. P. 461658, 1913, abst. J. S. C. I. 1914, **33**, 350. E. P. 410424, 1909; abst. J. S. C. I. 1910, **29**, 811.

9. E. P. 1959, 1910, abst. J. S. C. I. 1911, **30**, 19. F. P. 413901, 1910, abst. J. S. C. I. 1910, **29**, 101. D. R. P. 229450, 1909. Aust. Ann. A-2906, 1910. A. Eichengruen, E. P. 7118, 1913, 7899, 1914, abst. C. A. 1914, **8**, 2490, 3124; J. S. C. I. 1914, **33**, 178. E. P. 458114, 1913, abst. J. S. C. I. 1913, **32**, 939. Aust. P. 57984, abst. Kunst. 1913, **3**, 218. See also Eichengruen D. R. Ann. E-14210, E-14630, 1909. D. R. P. 268489, 1911, abst. C. A. 1914, **8**, 1489, Chem. Ztg. 1914, **38**, 20. E. P. 26987, 1912; abst. C. A. 1914, **8**, 1644. E. P. 17574, 1912. Snowden & Co., Belg. P. 241975, 1912, render cellulose acetate incombustible by means of aqueous boric acid. U. S. P. 1175728; abst. C. A. 1916, **10**, 1415.

10. D. R. P. 235381, 1911, abst. Wag. Jahr. 1911, **57**, II, 533. In this connection see F. Bayer & Co., D. R. Ann. F-27152, F-27686, of 1909. E. P. 25821, 1902, F. P. 326463, 1902, abst. J. S. C. I. 1903, **22**, 820; D. R. P.

G. Gawlich,¹ K. Goldstein,² Societe Balland et Cie,³ B. Borzykowski,⁴ A. Martens,⁵ Schlutting,⁶ H. Frederking,⁷ A. Little,⁸ A. Luck,⁹ E. Bouchard-Praceiq,¹⁰ E. Thomson and J. Callan,¹¹ General Electric Co.,¹² Societe Debaugue et Cie,¹³ H. Zwick,¹⁴ Societe D'Exploitation des Brevets Dolter,¹⁵ M. Zelensky,¹⁶ A. Campbell,¹⁷

169364, abst. Chem. Centr. 1900, **77**, II, 187. Wag. Jahr. 1906, **52**, II, 485. U. S. P. 752388, 1904. As prepared according to D. R. P. 153350; 1901 abst. Zts. ang. Chem. 1904, **17**, 1697; Chem. Centr. 1904, **75**, II, 625; Jahr. Chem. 1904, **57**, 1168; J. C. S. 1904, **86**, 853. D. R. P. 159524, 1901; abst. Chem. Centr. 1905, **76**, II, 527; Zts. ang. Chem. 1905, **18**, 1636; Jahr. Chem. 1905-1908, II, 984; J. C. S. 1906, **90**, 6. E. P. 21268, 1901; abst. J. S. C. I. 1902, **21**, 870. F. P. 317007, 1901; abst. J. S. C. I. 1902, **21**, 870; Mon. Sci. 1903, (4), **60**, 54. U. S. P. 754123, 1903; abst. J. S. C. I. 1903, **22**, 961; Mon. Sci. 1903, (4), **60**, 173. U. S. P. 790565, 1905; abst. J. S. C. I. 1905, **24**, 686. It. P. 31391, Can. P. 62042, 1901. D. R. P. 1801802, 292589; abst. C. A. 1917, **11**, 1310, 2410. F. P. 415048.

1. E. P. 16199, 1909; abst. J. S. C. I. 1910, **29**, 420; Aust. P. 46036.

2. D. R. P. 219116, 1908; abst. C. A. 1910, **4**, 2048; Chem. Zentr. 1910, I, 970.

3. F. P. 457925; abst. Kunst. 1913, **3**, 476. See also L. Canard, F. P. 417617; abst. Kunst. 1919, **9**, 190.

4. U. S. P. 1010222, 1911; abst. J. S. C. I. 1912, **31**, 24. F. P. 424428, 1910; abst. J. S. C. I. 1911, **30**, 740. E. P. 30398, 1910.

5. Mitt. kgl. Materialprüfungsamt, 1911, **29**, 57; abst. J. S. C. I. 1911, **30**, 414; C. A. 1911, **5**, 2943.

6. X. Deutschen Archivtag in Posen "Mitteilungen" 1911, Part 2, 57.

7. Mitt. kgl. Materialprüfungsamt, 1911, **29**, 360; abst. J. S. C. I. 1911, **30**, 1307; C. A. 1912, **6**, 421; Chem. Zentr. 1911, **62**, II, 1892; Zts. ang. Chem. 1912, **25**, 1549.

8. U. S. P. 532468, 1895. A. Little, E. P. 21913, 1913.

9. E. P. 24662, 1898. U. S. P. 649852, 1900.

10. F. P. 445770, 1912; abst. C. A. 1913, **7**, 1976.

11. U. S. P. 695127, 1902; Reissue 11997, 1902. E. P. 2264, 1902; abst. J. S. C. I. 1903, **22**, 303. English patent issued to British Thomson-Houston Co., Ltd. Wire insulated with cellulose acetate according to this process is known in the trade as "Cellestron." U. S. P. 792001, 1905.

12. E. P. 19565, 1902. Cf. E. P. 11997, 1902.

13. F. P. 418347, 1909; abst. J. S. C. I. 1910, **29**, 1117; 1911, **30**, 96. In addition No. 15217 to F. P. 418347 (abst. J. S. C. I. 1912, **31**, 651; Kunst. 1912, **2**, 316) is described the preparation of an infusible insulating varnish for electric construction and wire covering, in which cellulose acetate and hexachlorethane are mixed in about equal parts, the absorption of the latter by the former being produced by means of a common solvent such as tetrachlorethane. Other solvents such as alcohol or acetone may be used in addition. F. P. 453564, 1913.

14. D. R. P. 211520, 1907; H. Zwick, abst. Zts. ang. Chem. 1909, **22**, 1558; Chem. Zentr. 1909, **80**, II, 398; Wag. Jahr. 1909, **55**, II, 541, covers the use of cellulose nitrate for the above described purposes, whereas D. R. P. 211573, 1917, being addition to D. R. P. 211520; abst. Zts. ang. Chem. 1909, **22**, 1558; Chem. Zentr. 1909, **80**, II, 399, describes the use of cellulose acetates for the same purpose.

15. F. P. 375092, 1907; abst. J. S. C. I. 1907, **26**, 877.

16. E. P. 2156, 1906.

17. Proc. Roy. Soc. 1906, **78 A**, 196-211; abst. J. S. C. I., 1906, **25**, 935; Chem. Centr. 1906, **77**, II, 1184-1185.

W. Vieweg,¹ W. Doht,² Compagnie Gen. D'Electricite,³ P. La-grange,⁴ McTavish, Ramsay & Co., and A. Ramsay,⁵ A. Plaissetty,⁶ E. Valenta,⁷ I. Hoffsummer,⁸ L. Lederer,⁹ J. Smith and W. Merckens,¹⁰ J. Aylesworth,¹¹ Viscose Development Co., and J. Morford,¹² Societe Francaise des Tissue Blaies,¹³ Nottelle and R. Heraud,¹⁴ Akt. Ges. f. Anilin Fabrikation,¹⁵ Chemische Fabrik

1. Chem. Ztg. 1907, **31**, 85; abst. Chem. Centr. 1907, **78**, 1, 677.
2. Chem. Ztg. 1907, **31**, 302; abst. Zts. ang. Chem. 1907, **20**, 743.
3. D. R. P. 272695, 1911; abst. C. A. 1914, **8**, 2786.
4. F. P. 463619, 1912; abst. C. A. 1914, **8**, 2805.
5. E. P. 7038, 1913, abst. Kunst. 1914, **4**, 237.
6. E. P. 26381, 1897; 3770, 1898, 63, 1699; 9088, 1900; 20747, 1901, F. P. 621803, 1902; U. S. P. 768073, 1904, abst. J. S. C. I. 1899, **18**, 479, 746; 1901, **20**, 699; 1902, **21**, 1389, 1903, **22**, 547, 1904, **23**, 897.
7. Photo. Corr. 1901, 305, abst. Eder's Jahr., 1902, 582-583, Chem. Centr. 1901, **72**, II, 40; Jahr. Chem. 1901, **54**, 891.
8. E. P. 3855, 1904, abst. J. S. C. I. 1904, **23**, 622. F. P. 357473, 1905; abst. Mon. Sci. 1907, **67**, 43.
9. U. S. P. 25390, 1903; abst. J. S. C. I. 1904, **23**, 337.
10. U. S. P. 1140174; abst. Kunst. 1915, **5**, 239.
11. E. P. 26503, 1906; abst. J. S. C. I. 1907, **26**, 1295. F. P. 371358, 1906; abst. J. S. C. I. 1907, **26**, 344, Mon. Sci., 1908, **69**, 150. D. R. P. 191320, 1906; abst. Wag. Jahr. 1907, **53**, II, 507. Belg. P. 195837, 195848, 1906.
12. E. P. 2461, 1907; abst. J. S. C. I. 1907, **26**, 1109. Belg. P. 198836, 1907.
13. U. S. P. 855556, 1907, 953454, 1910; 962877, 1910; abst. J. S. C. I. 1910, **29**, 940. A and L. Lumiere, F. P. 338849, 1903, and First Addition 2694, and Second Addition 2707 of 1903. The Compagnie Generale de Phonographes, Cinematographes et Appareils de Precision (Swiss P. 68029; abst. Kunst. 1914, **4**, 98) combine acetylcellulose with an ether-oxide of glycerol. See also E. P. 2880, 1905.
14. E. P. 14194, 1910, abst. J. S. C. I. 1911, **30**, 888.
15. F. P. 427818, 1910, abst. Kunst. 1911, **1**, 455. L. Nottelle und R. Heraud (F. P. 445638, 1911, abst. J. S. C. I. 1913, **32**, 35) produce a varnish suitable for covering air craft by combining cellulose acetate with various gums and resins, acetone and amyl acetate, with or without the addition of rubber. After the varnish has been applied and has dried, the coating may be vulcanized by a coating of sulfur chloride. Addition 14044 to F. P. 427818, 1910; Kunst. 1911, **1**, 455. The Internationale Celluloseester Gesellschaft, D. R. P. 241963, 1908; abst. C. A. 1912, **6**, 2315; Chem. Tech. Rep., 1912, **36**, 110, have also patented the use of cellulose acetate as a filling or covering material in the construction of air craft. See this firm's D. R. P. 277529, 1909; abst. Kunst. 1914, **4**, 335 for use of resorcinol diacetate with acetated cellulose. Compare also Furst Guido Donnersmarck'sche Kunstseiden und Acetatwerke, Aust. P. 8165, 1902; Aust. Appl. 1905, 1909; Swiss P. 46329, 1909. For a description of the H. Dittmar process (D. R. P. 266384, 1911; abst. C. A. 1914, **8**, 2041).
16. F. P. 445638; abst. Kunst. 1913, **3**, 474; 1914, **4**, 38.
17. E. P. 5633, 1914. F. P. 463622, 1913; abst. J. S. C. I. 1914, **33**, 431; Kunst. 1914, **4**, 195. F. P. 449253, 1912; abst. J. S. C. I. 1913, **32**, 482. **32**, 132; E. P. 6798, 1911; abst. C. A. 1913, **7**, 3032; E. P. 21426, 1911; abst. J. S. C. I. 1912, **31**, 1027; C. A. 1913, **7**, 1108. D. R. P. Ann. 84; L-32835; abst. Kunst. 1913, **3**, 100. F. P. 461058, 1913; abst. J. S. C. I. 1914, **33**, 20. For "Emaillite" as an acetate proofing lacquer see W. Vieweg, Kunst. 1914,

von Heyden,¹ F. Laarmann,² J. Harris,³ C. Schroeder, L. Levi and A. Lasche,⁴ F. Meyer,⁵ E. Worden,⁶ J. Peck,⁷ Tondl & Co.,⁸ W. Muntz,⁹ R. Weeber,¹⁰ W. Longmate,¹¹ H. Chalmers,¹² H. Belnisch,¹³ W. Plinatus,¹⁴ C. van Pittius,¹⁵ G. Koller,¹⁶ J. and C. Bed-

4, 187; Firma L'Emaillite, Kunst. 1914, 4, 218. See also "Flight" of Jan. 10, 1910; Deutscher Lauftehrer-Zts. Feb. 17, 1914. Belg. P. 209561. Swiss P. 66488; abst. Kunst. 1919, 9, 189.

1. D. R. P. 241520, 211573; D. R. Anm. C-23158. D. R. Anm. C-23487. Kunst. 1913, 3, 478.

2. U. S. P. 1089482, 1914; abst. C. A. 1914, 8, 1679. For other methods of obtaining rubber foam see U. S. P. 753206, 753300, 857960; F. P. 329117; D. R. P. 174001.

3. U. S. P. 126698, 1872.

4. C. Schroeder, L. Levi and A. Lasche, U. S. P. 951582, 1910.

5. U. S. P. 931629, 1909; D. R. P. 193210, 1906, abst. Mon. Sci. 1911, (5), 74, 92. Can. P. 107996, 1907.

6. See E. Worden, "Acetate Collodion," Science, 1911, 34, 256; abst. Zts. ang. Chem. 1912, 25, 322. Cross and Bevan (U. S. P. 530826) first suggested cellulose acetate for pharmaceutical uses.

7. E. P. 2425, 1913; abst. C. A. 1914, 8, 2624. E. P. 23777, 1912. For the preparation of cellulose acetate in the presence of oxyacid esters or methylamine sulfate, see Knoll & Co., E. P. 2491, 4353, 16905, 1913. For the preparation of diethylsulfate, see L. Lilienfeld, E. P. 13882, 1913. U. S. P. 1054633, 1913, 1317648. D. R. P. 272339, 1913. F. P. 439282, 1913. Abst. C. A. 1913, 7, 4046; 1914, 8, 3100, 3840. Aust. P. 47237, 54719, 73001. Swed. P. 66512.

8. E. P. 15782, 1913.

9. E. P. 613, 1912.

10. E. P. 951, 1910.

11. E. P. 3991, 1913. For cellulose acetate, see E. Lemaire, La Nature, 1908-9, 37, 130. The cellulose acetate cement composition of A. Tessier (U. S. P. 1122554, 1913) intended as a cement for continuous photographic films, is composed of 3% non-inflammable film material as cellulose acetate 1% celluloid, 47% acetone, 21% chloroform and 21% glacial acetic acid, with or without aniline.

12. U. S. P. 1112890, 1914, abst. C. A. 1914, 8, 3841. In Swiss P. 65057, being Add. to Swiss P. 63585, H. Dreyfus prepares a celluloid substitute by the treatment of acetylcellulose with insufficient amounts of non-reacting aromatic alcohols in conjunction with chlorinated derivatives of acetylene, ethylene, methylene and ethylidene. Abst. Kunst. 1914, 4, 370.

13. D. R. P. 279638, 1913; abst. Kunst. 1914, 369. See Aust. P. 33508, same as E. P. 11164, 1902. Aust. P. 21614, same as D. R. P. 154657. See also Farb. v. Bayer & Co., Swiss P. 52903. Aust. Appl. 8776, 1910. Aust. P. 21213, 1905. A. Eichengruen, Swiss P. 51952, Knoll & Co., Aust. P. 33508, 34272, 1908; 41811, 1910; Belg. P. 244950, 1912. Akt. f. Anilin Fabrikation, Belg. P. 248907, 1912. Aust. P. 21213, same as F. P. 317007.

14. E. P. 25449, 25805, 1911; F. P. 450967; abst. Kunst. 1914, 4, 286. Compare E. P. 476, 1910.

15. E. P. 25274, 1910; abst. C. A. 1912, 6, 1527; J. S. C. I. 1911, 30, 1281. E. P. 555, 26334, 1910.

16. U. S. P. 1079733, 1913; Belg. P. 243162, 1912; abst. C. A. 1914, 8, 421. J. Bock (F. P. 469017; abst. Kunst. 1914, 4, 370) prepares water-insoluble, unflammable pearls by combining cellulose acetate with "pearl essence." For a process for producing cellulose acetate soluble in ethyl acetate, see F. Collischon, F. Ruppert and Verein für Chemische Industrie in Mainz, U. S. P. 1106512, 1914; F. P. 455117, 1913; abst. J. S. C. I. 1913, 32,

- ford and J. Kirk,¹ Societe des Manufacturers N. Konchine,² F. Lehmann,³ G. Stolle,⁴ A. Strobl,⁵ C. Vance and J. Vetter,⁶ K. Adel,⁷ M. Arosio,⁸ C. Baskerville,⁹ E. Bertarelli,¹⁰ Caldwell,¹¹ A. Constantin,¹² M. Dickert,¹³ J. Drapier, P. Dubois and Spiritine, Ltd.,¹⁴ H. Dreyfus,¹⁵ K. Haring,¹⁶ C. Henry,¹⁷ E. Hermet,¹⁸ P. Hewitt,¹⁹ G. Heyl,²⁰ F. Khitti,²¹ Knoll & Co.,²² P. Kraus,²³ A. Pellerin,²⁴ B. Mac-
- 865; 1914, **33**, 958, C. A. 1914, **8**, 3502. For cellulose alkyl esters prepared by treatment of cellulose with alkali, then with methyl sulfate or ethyl chloride, consult H. Dreyfus, F. P. 462274, 1912, abst. C. A. 1914, 3859. For modification of solubility of cellulose acetate, see E. Knoevenagel, Kunst. 1914, **4**, 344. See Wedorf, Kunst. June 1, 1920, translated by C. West, Paper, 1920, **26**, 15.
1. E. P. 28293, 1909. See also E. P. 16102, 1902, 17430, 1903; 19060, 1904. For the Ruffusay and Lewis method of manufacturing cellulose fatty acid esters, see E. P. 22718, 1904. See Belg. P. 261288, abst. Kunst. 1914, **4**, 393, same as F. P. 463498, 1913. The Cohoe process of acetic acid manufacture is described in E. P. 23573, 1910, and the H. Sulzer method of formates manufacture is detailed in Belg. P. 212325, 1912. The Deutsche Gasguelicht Aktges. (E. P. 75, 1915) describe methods for producing fatty acid esters of cellulose containing over 20% of combined fatty acid.
2. F. P. 469371, 1914, abst. J. S. C. I., 1915, **34**, 26. The Chemische Werke vorm H. Byk (Belg. P. 261693, abst. Kunst. 1914, **4**, 378) produce acetylcellulose lacquers by the employment of lactic acid esters as adjuncts and plastic-forming bodies, either in the presence or absence of hydrocarbons.
3. F. P. 469925, 1914, abst. J. S. C. I. 1915, **34**, 25. The Soc. Chimique des Usines du Rhone, Ancienement Gilhard, P. Monnet et Cartier, E. P. 25893, 1911, produce cellulose acetates by treating cellulose with acetic acid and acetic anhydride vapors. The Verein fur Chemische Industrie in Mainz, E. P. 19008, 1913, claim to have improved upon their E. P. 21928, 1901, for obtaining cellulose esters soluble in ethyl acetate, or for the production of an ester.
4. E. P. 23289, 1913, 12719, 1914, abst. C. A. 1918, **12**, 1113.
5. U. S. P. 1266080, 1277119, 1918, abst. C. A. 1918, **12**, 1698, 2021; J. S. C. I. 1918, **37**, 499-A, 682-A.
6. U. S. P. 1295241, 1919, abst. C. A. 1919, **13**, 1248.
7. Belg. P. 258779, 1913.
8. E. P. 131916, 1919, abst. C. A. 1920, **14**, 359.
9. U. S. P. 1208265, 1916, abst. C. A. 1917, **10**, 297.
10. Zentr. Bakter. u. Parasitenk. 1915, I, **76**, 463, abst. Chem. Zentr. 1915, **86**, II, 865.
11. E. P. Appl. 878, 1917, abst. J. S. C. I. 1917, **36**, 9.
12. E. P. 17338, 1912.
13. U. S. P. 1180704, 1916, abst. C. A. 1916, **10**, 1710; J. S. C. I. 1916, **35**, 643.
14. E. P. 24146, 1902, abst. J. S. C. I. 1902, **21**, 1524.
15. E. P. 132283, abst. J. S. C. I. 1919, **38**, 745-A.
16. U. S. P. 1179357, 1916; abst. C. A. 1916, **10**, 1608.
17. E. P. 20092, 1899.
18. E. P. 6473, 1895.
19. E. P. 16271, 1911.
20. E. P. 8154, 1914.
21. E. P. 680, 1913.
22. Aust. P. 67814, abst. Kunst. 1914, **4**, 94.
23. D. R. P. 302611, 1917; abst. J. S. C. I. 1918, **37**, 332-A.
24. E. P. 7748, 1910.

Donald,¹ A. Meygret,² W. Muntz,³ F. Paschke,⁴ Panels Ltd.,⁵ Reichhold, Flügler & Boecking Stadlauer Lackfabrik,⁶ L. Riley,⁷ Siemens-Schuckert-Werke,⁸ Societe Anon. Pour l'Exploitation des Procédes Westinghouse Leblanc,⁹ and A. Nitshill.¹⁰

Cellulose Xanthates. *Section Twelve.* This subject is comprehended historically under the following headings:

1. *Viscose, Historical*, (3062).
2. *Manufacture of Viscose* (3064).
3. *Commercial Applications* (3072), viscose artificial filaments (3072), viscose films and sheets (3074), viscid masses (3076), finishing of fabrics (3077), viscose plastics (3079).
4. *Xanthates of the Carbohydrates* (3083).

Viscose.¹¹ The history of this product commences in 1892,

1. E. P. 714, 1914; abst. J. S. C. I. 1915, **34**, 239.
 2. E. P. 1676, 1903; abst. J. S. C. I. 1904, **23**, 119.
 3. U. S. P. 1184257, 1916; abst. C. A. 1916, **10**, 1950.
 4. E. P. 15880, 1913; abst. C. A. 1915, **9**, 137.
 5. E. P. 136214.
 6. Aust. P. 70772, 1915; abst. C. A. 1916, **10**, 1407.
 7. E. P. 24777, 1914.
 8. D. R. P. 177667, 282057, 1912; abst. C. A. 1915, **9**, 2353.
 9. E. P. 1460, 1912.
 10. E. P. 12839, 1915; abst. J. S. C. I. 1916, **35**, 1057.
 11. Asbarand, Zts. anorg. Chem. 1903, **16**, 143. C. Bardy, Bull. de la Soc. d'Encouragement pour l'Indus. Nat. 1900, (5), **5**, 321; abst. Gen. Civ. 1900, **37**, 382. F. Beltzer, Mon. Sci. 1908, II, 5, Faerber. Ztg. 1908, 168; Wag. Jahr. 1908, II, 369.
- Rev. gén. chim. 1910, **13**, 72. Tech. Mod. 4, No. 5, 7, 9; abst. Ind. Chim. 1910, **10**, 247, 261; C. A. 1911, **5**, 195. Mon. Sci. 1910, (4), **24**, 145. Rev. Chim. Ind. **21**, 329; abst. C. A. 1911, **5**, 789, 1519; Chem. Zentr. 1910, II, 509. Kunst. 1912, **2**, 41, 69, 85, 111, 127, 201; abst. C. A. 1912, **6**, 2314; Wag. Jahr. 1912, II, 445; Mon. Sci. 1912, (5), **3**, 5; 1913, **78**, 1; abst. Chem. Zentr. 1913, I, 669.
- J. Deghuée, School. of Mines Quart. 1892, **13**, 312; abst. J. S. C. I. 1893, **12**, 535. See also Scheibler, Neu Zts. Zucker Ind. I, 1881, **7**, 216. W. Dreaper, J. Soc., Dyers and Col. 1907, **23**, 25; abst. C. A. 1907, **1**, 779. Elbee, Cosmos, 1904, **50**, 789, Goldsmith, Papierfab. 1908, 3003; abst. Rep. Tech. J. Lit. 1908, 166. E. Hanausek, Oesterr. Chem. Ztg. 1900, 568; abst. Wag. Jahr. 1900, II, 452. A. Haussner, Dingl. Poly. 1909, **324**, 569; abst. C. A. 1909, **3**, 1459. L. Lefevre, Rev. Gen. Mat. Col. 1897, 133; 1898, 249; Nature, 1898, **26**, 146. Lehne's Farb. Ztg. 1898, **9**, 190. Leipz. Farb. Must. Ztg. 1899, **46**, 39. A. Little, J. Frank. Inst., **133**, 111; abst. J. S. C. I. 1895, **14**, 59. See also J. S. C. I. 1893, **12**, 498; 1894, **13**, 900. W. Loebel, E. P. 26383, 1904. F. P. 348761, 1904. D. R. P. 175383; abst. Zts. ang. Chem. 1907, **20**, 837; Chem. Centr. 1906, II, 1150. M. Manoukian, Chem. Ztg. 1900, **24**, 424. C. Cross E. Bevan and C. Beadle, U. S. P. 520770, 1894. E. P. 8700, 1892; abst. J. S. C. I. 1893, **12**, 518; D. R. P. 70999, 1893; 138511. E. P. 409, 1894. F. P. 227034, 1893; abst. Mon. Sci., (4), **7**, 209; Jahr. Chem. 1893, 886; U. S. P. 604206. D. R. P. 70999, 1893; abst. Wag. Jahr. 1893, 1001; 1897, 1121; Chem. Centr. 1894, I, 365. Can. P. 45845, 1894. Aust. P. Aug. 28, 1893. Feb. 9, July 15, 1895. Belg. P. 103093, 1893. Ital. P. 33347, 1896. (See

in which year C. Cross, E. Bevan and C. Beadle received patent protection for a method of treating cellulose with alkali and adding to the alkali cellulose thus formed, varying amounts of carbon disulfide, whereby a homogeneous solution was formed of cellulose thiocarbonate (xanthate) to which the name of "viscose" was applied. It was subsequently found that the cellulose regenerated from this solution had many commercial possibilities, especially for the formation of artificial filaments (lustracellulose). Their work on the theoretical aspects of the cellulose xanthates appeared in 1893,¹ and on cellulose xanthic acid in 1901.² The problems connected with xanthate formation were investigated by C. Stearns,³ S. Ferenczi,⁴ F. and A. Lehner,⁵

Cross, Bevan and Beadle, separately and collectively) B. Margosches, Zts. Ges. Tex. Ind. 1901, **3**, 210, 227, 243, 259, 275, 290, 307, 1904, **7**, 601, 615, 643, 657, 669, 671, 685, 713, 1905, **8**, 57, 74, 85, 337, 519, 533, 561, 575, 589, 617, 1906, **9**, 61, 75, 89, 173, abst. Chem. Centr. 1903, **1**, 263, 1904, **11**, 269; Zts. ang. Chem. 1905, **18**, 1988, Chem. Centr. 1906, **1**, 1382, Farben Ztg. 1906, **11**, 1097; Rep. Tech. J. Lit. 1906, 1299, Gummi Ztg. 1902, No. 46, 1904, No. 16; "The Celluloid Industrie" 1904, No. 16. Oberlander, E. P. Appl. 6022, 1913. Prudhomme, Mon. Tent 1902, **46**, 213. Schulze, Gummi Ztg. 1897, **12**, 21. F. Westhoff, Papier Fabr., **9**, 1551, abst. C. A. 1912, **6**, 1363, Zts. ang. Chem. 1912, **35**, 776. C. A. 1911, **5**, 2554. O. Witt, Papier Ztg. 1900, **25**, 2787; Verh. V. Gew. Z. B. 1904, 71, Lehm's Ztg. 1904, **15**, 222. Rep. Tech. J. Lit. 1904, 1038. See also Mitth. Gen. Mus. **10**, 35. C. N. 1881, **44**, 106; 1882, **45**, 13. Chem. Tech. Rep. (Jacobs) 1882, **21**, 11, 168. Chem. News, 1893, **67**, 236. Neues Erfindungen und Erfahrungen 1894, **21**, 36. Paper and Press, 1895, **20**, 255. Rev. Sci. 1896, (4), **6**, 477. Chem. News, 1897, **75**, 74, 86. Gummi-Ztg. 1898, **12**, 164, Must. Ztg. 1898, **48**, 39. Meyer. Jahr. 1898, **8**, 483. Mon. Sci. 1899, 601, Gen. Civ. 1900, **37**, 382. Sci. Am. Suppl. 1902, **53**, 21877. Gen. Civ. 1905, **46**, 406, Rep. Tech. J. Lit. 1905, 999. Farben Ztg. 1906, **11**, 1097. Gummi-Ztg. 1907, **13**, (Nov. 8.), abst. C. A. 1908, **2**, 458. Daily Consular Report 1910, N. S. **1**, No. 2, 310; 1911, No. 70, 1148. Chem. Ztg. 1911, No. 126. Manchester (Eng.) Guardian, Jan. 2, 1911.

1. Cross, E. P. 4713, 1896, abst. J. S. C. I. 1896, **15**, 350, U. S. P. 604206, (Cross, Bevan, Beadle); D. R. P. 92590, abst. Jahr. Chem. 1897, 1506; Chem. Centr. 1897, **11**, 365, 655, Wag. Jahr. 1897, 1121. Hung. P. Jar. **9**, 1896; Aust. P. March 26, 1897; Russ. P. April 24, 1896, 26004, 1899; Port. P. 2325, 1897; (Cross, Bevan and Beadle, E. P. 261540, 1896; U. S. P. 717355; Dan. P. Jan. 12, 1897).

2. C. Cross, E. Bevan and C. Beadle, J. C. S. 1893, **63**, 837; abst. Ber. 1893, **26**, 1090; C. N. 1893, **67**, 236; J. S. C. I. 1893, **12**, 498. Chem. Centr. 1893, **11**, 32, 319; Bull. Soc. Chim. 1893, (3), **9**, 295; Chem. Tech. Rep. 1893, **32**, **11**, 171; J. S. C. I. 1896, **15**, 317. Haber, Dingl. Poly. 1894, **294**, 210.

3. Ber. 1901, **34**, 1513; abst. J. S. C. I. 1901, **20**, 740; Chem. Centr. 1901, **11**, 94; Jahr. Chem. 1901, 891; J. C. S. 1901, A. i., 452. See also Zts. Farben. Tex. Chem. 1904, **3**, 197; Chem. Zentr. 1904, **11**, 197. Paper Making 1907, **23**. Lindemann and Matten, Bull. Acad. Roy. Belg. (3), **23**, 827; Gardner, Muster Ztg. 1896, **45**, 507.

4. U. S. P. 716778, 1902; abst. J. S. C. I. 1903, **32**, 22; E. P. 7022, 1903 abst. Chem. Ztg. 1904, **28**, 718; J. S. C. I. 1903, **32**, 879; F. P. 330753, 1903. Can. P. 62831, 1899; E. P. 1020, 1021, 1022, 1908; 16604, 1903; Belg. 174194 1903; D. R. P. 108511, abst. Chem. Centr. 1900, **1**, 1149; Ber. 1898, **28**, 999

L. Lilienfeld,¹ A. Burette,² C. Leclaire,³ A. Semenov,⁴ Vereinigte Glanzstoff Fabriken,⁵ H. Jentgen,⁶ A. Beinstein,⁷ and many others, primarily along lines of viscose manufacture for artificial filament formation.

The general method of viscose formation⁸ is to steep selected wood pulp in 17.5% NaOH solution,⁹ and after it has under-

Lux P. 5235, 5236, 1903; Aust. P. 16112, 1904, Swiss P. 19135, 1899, Span. P. 31479, 1903; See also *Stärn*, J. Soc. Dyers, 1903, **19**, 230; C. Süvern, Chem. Zts. 1902-03, **2**, 540.

5. Zts. ang. Chem. 1899, **13**, 11, 51; abst. Wag. Jahr. 1899, 1066; Mon. Text. Ind. 1899, **14**, 93; Chem. Centr. 1899, I, 459, 573; Papier Ztg. 1899, **24**, 31, 43, 78; Amer. Apoth. Ztg. 1899, **20**, 93.

6. U. S. P. 724020, 1903; abst. J. S. C. I. 1903, **22**, 569; Mon. Sci. 1903, (4), **59**, 63; E. P. 17503, 1902; F. P. 323474.

1. U. S. P. 980648, 1911; abst. J. S. C. I. 1911, **30**, 126; E. P. 8708, 1908; abst. J. S. C. I. 1909, **28**, 257; D. R. P. 228836, 1906; abst. C. A. 1911, **5**, 2177; Zts. ang. Chem. 1911, **24**, 138; Chem. Zentr. 1911, I, 50, Wag. Jahr. 1910, II, 435. E. P. 1378, 1912; abst. C. A. 1913, **7**, 2307. E. P. 14339, 1914. F. P. 474793, 1914. D. R. P. 262868, 1911; abst. Kunst. 1913, **3**, 279, 332; C. A. 1913, **7**, 3663. D. R. P. Ann. I. 31671, 1911; abst. Kunst. 1912, **2**, 300. D. R. Ann. I. 33725, 1912; abst. Kunst. 1912, **2**, 479.

Aust. P. 62810, 1913. Aust. Ann. 590, 1911; 355, 1912. Hung. Ann. I. 2738, 1912; F. P. 222855, 1910.

2. F. P. 430221, 1911; abst. J. S. C. I. 1911, **30**, 1308; Kunst. 1912, **2**, 17.

3. E. P. 20593, 1909; abst. J. S. C. I. 1910, **29**, 1152; Kunst. 1911, **1**, 34; F. P. 402804, 1908; abst. J. S. C. I. 1909, **28**, 1270, F. P. 10029, 1909.

Add. to F. P. 402804, 1908; abst. J. S. C. I. 1910, **29**, 83. F. P. 414520 1909; 419872, 1909; abst. J. S. C. I. 1911, **30**, 205.

4. J. Russ. Phys. Chem. Soc. 1912, **44**, 339; abst. J. S. C. I. 1912, **31**, 428; C. A. 1912, **6**, 1525. See Russ. P. 15773, 16152, 1909.

5. E. P. 834, 826, 1914. D. R. P. Ann. B. 10658, 1912; abst. Kunst. 1914, **4**, 260. D. R. Ann. V. 11585, 1913; abst. Kunst. 1914, **4**, 396. V. 12177, 12178, 1913; abst. Kunst. 1914, **4**, 396, 412. Swiss P. 70124; abst. Kunst. 1915, **5**, 274. See Erste Oesterreichische Glanzstoff Fabrik A.-G., Aust. P. Ann. 8008, 1911; 4169, 1912; 7723, 1913; Aust. P. 61811, 1913.

6. D. R. P. Ann. J. 14089, 1911; abst. Kunst. 1912, **2**, 420. Papierfabr. 1913, **11**, 984; abst. J. S. C. I. 1913, **32**, 864; C. A. 1914, **8**, 245. Kunst. 1913, **3**, 145, 161, 186, 227, 249; abst. C. A. 1913, **7**, 3029.

7. U. S. P. 1121605, 1914; abst. J. S. C. I. 1915, **34**, 75; C. A. 1915, **9**, 377; F. P. 462147, 1913; abst. J. S. C. I. 1914, **33**, 196; C. A. 1914, **8**, 2947, Kunst. 1914, **4**, 172. D. R. P. Ann. B. 68090, 1912; abst. Kunst. 1913, **3**, 300. Belg. P. 250495, 1912; abst. Chem. Ztg. Rep. **37**, No. 132, 1352. See also Beucke, and E. Collin, Ann. Fals. 1913, **6**, 342; abst. C. A. 1913, **7**, 2476, 3232.

8. American Viscose Co., Can. P. 66000, 1900. Compagnie Francaise des Applications de la Cellulose, D. R. P. Ann. B. 62032, 1911; abst. Kunst. 1913, **3**, 459; Hung. Ann. A. 1675. Faust, Papierfabr. 1904, 655; abst. Rep. Tech. J. Lit. 1904, 1241. P. Gigard, Belg. P. 247900, 1912; abst. Kunst. 1913, **3**, 178. O. Glum & Co., D. R. P. 217316, 1909; abst. Chem. Zentr. 1910, I, 490. Le Soc. Francaise de la Viscose, E. P. 5730, 1904. R. Strehlenet, Chem. Ztg. 1900, **24**, 1149. N. Erfindungen und Erfahrungen 1895, **22**, 513; 1907, **34**, 487; abst. Rep. Tech. J. Lit. 1907, 203. A. Leighton (J. Phys. Chem. 1916, **20**, 32, see this vol., p. 100, note 1) has studied the absorption of sodium hydroxide by cellulose.

9. E. Bloch-Pimentel, E. P. 7893, 1912; abst. C. A. 1913, **7**, 3237. J.

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F. Beltzer and F. Theubert, F. P. 322028, 1902, abst. J. S. C. I. 1903, **22**, 295.
J. Bemberg, D. R. P. 219943, 1911, abst. J. S. C. I. 1912, **31**, 1121. F. P.
368709, 1906, abst. J. S. C. I. 1907, **26**, 17. P. Berens, F. P. 364577, 1906,
abst. J. S. C. I. 1906, **25**, 1012. G. Boudin, F. P. 402412, 1913, abst. J. S. C. I.
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Bourcart, Rev. gen. mat. col. 1902, **6**, 319, abst. J. S. C. I. 1902, **21**, 403.
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abst. J. S. C. I. 1903, **22**, 918. British Cotton & Wool Dyers' Association,
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Warr, E. P. 11525, 1902, abst. J. S. C. I. 1903, **22**, 621. R. Chevolleau, F. P.
324848, 1902, abst. J. S. C. I. 1903, **22**, 625. F. Chambers and T. C. Hammond,
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F. Cochran, E. P. 21192, 1899, abst. J. S. C. I. 1900, **19**, 845. B. Colman, E. P.
11032, 1899, abst. J. S. C. I. 1900, **19**, 741. J. F. Copley, E. P. 9937, 1899, abst.
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1899, abst. J. S. C. I. 1900, **19**, 437. W. and L. Craven, C. Young, F. and W.
Cliffe, U. S. P. 1165570, 1915, abst. J. S. C. I. 1916, **35**, 251. W. Crompton and
W. Horrocks, E. P. 11077, 1905, abst. J. S. C. I. 1901, **20**, 985; 1902, **21**, 405,
1904, **23**, 659, 1905, **25**, 616. D. Crowther, E. P. 22095, 1899, abst. J. S. C. I. 1900,
1910, 1911, 1912, **31**, 1121. T. de Naeyer, E. P. 20959, 1903, abst. J. S. C. I.
1904, **23**, 185, 1026. J. Dolder, E. P. 11436, 1900, abst. J. S. C. I. 1900, **19**,
821, 1902, **21**, 342. J. Donnelly, Rev. gen. mat. col. 1913, **17**, 303, abst.
J. S. C. I. 1913, **32**, 1064. E. Drum and J. H. Skitt, U. S. P. 983542,
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abst. J. S. C. I. 1901, **20**, 359, 1902, **21**, 491; 1903, **22**, 1013. P. Edlich, U. S. P.
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house, 1912, **82**, 549, abst. J. S. C. I. 1912, **31**, 1120. M. Frings, E. P. 23470,
1900, abst. J. S. C. I. 1902, **21**, 171. M. Friedrich, F. P. 424247, 1910, abst.
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1906, **25**, 373, 755. G. Grandage, E. P. 13511, 1899, abst. J. S. C. I. 1899, **28**,
911. D. Habel, E. P. 83906, 1910, abst. J. S. C. I. 1910, **29**, 1372. W. Harri-
son, J. Soc. Dyers and Col. 1915, **31**, 198, abst. J. S. C. I. 1915, **34**, 1087.
P. Hahn, E. S. P. 1087442, 1911, abst. J. S. C. I. 1914, **33**, 350. E. P. 14702,
1914; J. S. C. I. 1914, **33**, 641. E. P. 21539, 1912, abst. J. S. C. I. 1913, **32**, 422.
P. Hahn, U. S. P. 1063911, 1913, abst. J. S. C. I. 1913, **32**, 85. U. S. P. 994076,
abst. J. S. C. I. 1911, **30**, 790, 1903, 1157. F. P. 441730, abst. J. S. C. I. 1914, **33**,
813. E. P. 225349, 1911, abst. J. S. C. I. 1912, **31**, 837. F. P. 435150, 1911; abst. J.
S. C. I. 1912, **31**, 330, 813. E. P. 21052, 1909, abst. J. S. C. I. 1910, **29**, 1200, 418.
F. P. 401004, 1909, abst. J. S. C. I. 1909, **28**, 1085. F. P. 325230, 1902, abst. J. S.

formation, it has then become alkali cellulose, having under-

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gone a process of ageing, is "xanthated" by treatment with CS_2 .¹ The product is further matured ("ripened") under temperature and time control,² filtered,³ the excess of carbon disulfide removed,⁴ and the air in solution removed by vacuum.⁵ The crude cellul-

1042 O. Venter, E. P. 2876, 1907, abst. J. S. C. I. 1908, **27**, 1017-1057; E. P. 15352, 1907, abst. J. S. C. I. 1909, **28**, 19. L. Wallach, E. P. 18312, 1907, F. P. 388278, abst. J. S. C. I. 1908, **27**, 331, 897. L. Weldon, E. P. 21498, 1899, abst. J. S. C. I. 1900, **19**, 115. Windsor Co., U. S. P. 739580, 1903; abst. J. S. C. I. 1903, **22**, 1127. A. Wyser, E. P. 222429, 1899, abst. J. S. C. I. 1900, **19**, 1011, 1904, **23**, 898. T. R., Foreign Office Annual Series 2671, abst. J. S. C. I. 1901, **20**, 953.

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2. Chem. Fabr. von Heyden, E. P. 20472, 1912, abst. J. S. C. I. 1913, **32**, 1153; C. A. 1914, **8**, 1668, Chem. Ztg. 1913, **37**, 1536, F. P. 446449, 1912; abst. J. S. C. I. 1913, **32**, 133, Kunst. 1913, **3**, 54. See also E. P. 2529, 17503; 1902, 10094, 1906, 21105, 1907, 5595, 1908, 406, 1911, 27732, 1912. F. P. 449536, 1912, abst. J. S. C. I. 1913, **32**, 482. D. R. P. Anm. C. 21327, 1911; abst. Kunst. 1913, **3**, 60. Aust. P. 56757; abst. Kunst. 1913, **3**, 75. Belg. P. 212513, 1912. Courtaulds, Ltd., W. Glover, and L. Wilson E. P. 13035, 1914, abst. C. A. 1915, **9**, 3130, J. S. C. I. 1915, **34**, 606, Chem. Ztg. 1914, **38**, 354, F. P. 434501, 1911; 477492, 1915; abst. J. S. C. I. 1916, **35**, 597. (Courtaulds, Ltd. and L. Wilson) E. P. 14675, 1914, abst. J. S. C. I. 1915, **34**, 606; F. P. 477493, 1915; abst. J. S. C. I. 1916, **35**, 597. Swiss P. 71681, 1916; abst. C. A. 1916, **11**, 1790. Courtaulds, Ltd., W. Glover and L. Wilson, D. R. P. 323784, 323785, Chem. Ztg. 1920, **44**, 409. Ital. P. 120481, 1911. E. P. 5595, 1908. Can. P. 194262, 1919. E. P. 104364, 127155. C. Ernst, E. S. P. 863793, 1907. W. Gardner, Muster. Ztg. 1896, **45**, 507. R. Haller, Zt. Farb. Text. Ind. 1904, **3**, 81. See also First Austrian Soda Works, D. R. P. 115856, 1899. La Soc. anon. pour la Fabrication de la soie de Chardonneil D. R. P. 270051, 1911, abst. C. A. 1914, **8**, 2258, Kunst. 1914, **4**, 60, 97. L. Naudin, U. S. P. 986306, 1911, abst. J. S. C. I. 1911, **30**, 416; F. P. 37412, 1906; abst. J. S. C. I. 1907, **26**, 775; D. R. P. 223736; Aust. P. 35267; E. I. 8179, 1907. See also D. R. P. 223736, 1907. Vereinigte Kunstseide-Fab. Akt. Ges. F. P. 317094, 1901, 323473, 323474, 323475, 1902, D. R. P. 125306, 155745, 183623, 1902; Belg. P. 164909, 1902, E. P. 17501, 1902. For determining the degree of ripening of viscose, consult V. Hottenroth, Chem. Ztg. 1915, **39**, 119; abst. J. S. C. I. 1915, **34**, 274. C. A. 1915, **9**, 4699.

3. M. Waddell, U. S. P. 846879, 1907; D. R. P. 204215; F. P. 375633; E. P. 5981, 1907; abst. J. S. C. I. 1908, **27**, 499; U. S. P. 849870, 1907; abst. J. S. C. I. 1907, **26**, 525. E. P. 7090, 1908; U. S. P. 823009, 1906. U. S. P. 876901, 1908. C. Ernst and G. Hamlin, abst. J. S. C. I. 1908, **27**, 178.

4. O. Eberhard, E. P. 2149, 1912. Soc. France de la Viscose, F. P. 332515, 1903; abst. J. S. C. I. 1904, **23**, 75.

5. L. Naudin, U. S. P. 767431, 1904; abst. J. S. C. I. 1904, **23**, 880; E. P. 52861904; abst. J. S. C. I. 1905, **24**, 149, 821. F. P. 340690, 1904; abst. J. S. C. I. 1904, **23**, 834; D. R. P. 163661, 1904; abst. Chem. Centr. 1906, I, 171; Wag. Jahr. 1905, II, 386; Aust. P. 19041, Swiss 30768. Can. P. 113817, 1908; Belg. P. 173572, 175756, 1904; 198898, 1907; E. P. 8179, 1907; abst. J. S. C. I. 1907, **26**, 36; F. P. 374123, 1906; abst. J. S. C. I. 1907, **26**, 775; Mon. Sci. 1908, (4), 68, 28. U. S. P. 986306; abst. J. S. C. I. 1907, **26**, 775; D. R. P. 223736; abst. Chem. Zentr. 1910, II, 525; Wag. Jahr. 1910, II, 434; Jahr. Chem. 1910, 429, Aust. P. 35267. See also E. P. 17501, 17502, 17503, 1902;

lose xanthate thus formed, which is of an orange to brown color, is "precipitated" to the viscid (regenerated cellulose) stage by inorganic salts or dilute acids,¹ and submitted to purification

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- I. H. Lange and G. Walther, E. P. 12822, 1914; abst. J. S. C. I. 1915, **34**, 956; F. P. 473256, 1914; abst. J. S. C. I. 1915, **34**, 546. D. R. P. Ann. L. 39873, 1913; abst. Kunst. 1914, **4**, 260. Holl. P. 2207, 1917; abst. C. A. 1918, **12**, 867. U. S. P. 1292544, 1919, J. S. C. I. 1919, **38**, 250-A. G. Lacroix, Belg. P. 256901; abst. Kunst. 1914, **4**, 155. L. Leduc and H. Jacquemin, U. S. P. 1214931, abst. C. A. 1917, **11**, 1046, E. P. 3168, 3169, 1913; abst. C. A. 1914, **8**, 421, 2624, J. S. C. I. 1913, **32**, 1153; F. P. 454061, 1913; abst. J. S. C. I. 1913, **32**, 865; C. A. 1914, **8**, 421; Kunst. 1913, **3**, 355; Swiss P. 62810, 1913. Ital. P. 131291, 1913. Belg. P. 253537. L. Lilienfeld, E. P. 15306, 1909; abst. J. S. C. I. 1910, **29**, 1005, E. P. 14339, 1914; abst. J. S. C. I. 1915, **34**, 830 (see also E. P. 1378, 1912, abst. J. S. C. I. 1913, **32**, 192). S. Peessarer, (spelled various ways) E. P. 16583, 1905; abst. J. S. C. I. 1906, **25**, 691; F. P. 457056, 1905; abst. J. S. C. I. 1906, **25**, 70; Belg. P. 186556, 1905; D. R. P. Ann. 15330; Can. P. 102276, 1906; Aust. P. 29835. Norw. P. 15185, 1905. H. Seidel, Mitt. Technol. Gewerb.-Mus. 1900, **10**, 33, abst. Wag. Jahr. 1900, II, 451, Chem. Centr. 1900, I, 442; J. S. C. I. 1900, **19**, 369. C. Stearn and Topham, E. P. 16604, 1903, abst. J. S. C. I. 1904, **23**, 784; Belg. P. 174195, 1903. D. R. P. 408511, 1898, abst. Chem. Centr. 1900, I, 1149. K. Süvern, Kunst. 1912, **2**, 444, abst. C. A. 1913, **7**, 551; Kunst. 1913, **3**, 447; abst. C. A. 1913, **7**, 576; Kunst. 1916, **6**, 165; abst. C. A. 1917, **11**, 1306. The Viscose Ltd. and C. Cross, U. S. P. 763266; abst. J. S. C. I. 1904, **23**, 758, E. P. 21030, 903, abst. J. S. C. I. 1903, **22**, 1363; F. P. 309548, 1901; abst. J. S. C. I. 1902, **21**, 65. F. P. 271145, 1897, abst. Rev. gén. mat. color. 1898, **2**, 128. R. P. 133144; abst. Wag. Jahr. 1902, II, 596, Jahr. Chem. 1902, 1053; Chem. Centr. 1902, II, 612, Zts. ang. Chem. 1902, **15**, 838. Belg. P. 155664, 1901.
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 1902; abst. J. S. C. I. 1902, **21**, 1230; E. P. 20638, 1901, abst. J. S. C. I. 1902,
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 27076, 1912; abst. C. A. 1914, **8**, 1875; J. S. C. I. 1913, **32**, 907. J. Soc. Dyers
 and Col. 1913, **29**, 326; F. P. 451276, 1912, abst. J. S. C. I. 1913, **32**, 596,
 Kunst. 1913, **3**, 214; Mon. Sci. 1914, **4**, 43; Rev. gén. mat. col. 1913, 290,
 C. A. 1913, **7**, 3234; F. P. 453569, 1913, abst. C. A. 1913, **7**, 3422; J. S. C. I.
 1913, **32**, 785; Kunst. 1913, **3**, 275. See also E. P. 22436, 20472, 1912. Belg.
 P. 248154; abst. Kunst. 1913, **3**, 178; Belg. P. 253139, abst. Kunst. 1913, **3**, 357,
 Belg. P. 251829; abst. Kunst. 1913, **3**, 235, 1914, **4**, 237. Swiss P. 61900, abst.
 Kunst. 1914, **4**, 273. Ital. P. 133989, 1913, abst. Chem. Ztg. Rep. 1913, **37**, 1341.
 Aust. P. Ann. A. 4279, 1913, abst. Kunst. 1914, **4**, 260. Chem. Fabrik.
 Heidenau, Aust. P. Ann. A. 406, 1912, abst. Kunst. 1912, **2**, 399. Chem.
 Fabrik, von Heyden, E. P. 22436, 1912, abst. C. A. 1914, **8**, 1016; J. Soc.
 Dyers and Col. 1913, **29**, 301; J. S. C. I. 1913, **32**, 748; E. P. 449536, 1912,
 abst. J. S. C. I. 1913, **32**, 482; Kunst. 1913, **3**, 157. E. P. 27732, 1912, abst.
 J. S. C. I. 1913, **32**, 597; C. A. 1913, **7**, 3233; F. P. 451156, 1912, abst. J. S. C. I.
 1913, **32**, 596; C. A. 1913, **7**, 3234; Kunst. 1913, **3**, 214. D. R. P. Ann. C.
 21811, 1912; abst. Kunst. 1913, **3**, 420. C. 21777, abst. Kunst. 1914, **4**, 20.
 S. Napper, U. S. P. 1045731, abst. J. S. C. I. 1913, **32**, 19; C. A. 1913, **7**, 706.
 E. P. 406, 1911; abst. J. S. C. I. 1911, **30**, 1308; Kunst. 1912, **2**, 16; F. P.
 434501, 1911, abst. J. S. C. I. 1912, **31**, 279. E. P. 21405, 1907, abst. J. S. C. I.
 1908, **27**, 1056; C. A. 1909, **2**, 1311. E. P. 5595, 1908, abst. J. S. C. I. 1908,
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 Bevan and Beadle, U. S. P. 717355, 1902, abst. J. S. C. I. 1903, **22**, 160; Ital. P.
 309548, abst. J. S. C. I. 1902, **21**, 65. Can. P. 70638, 1902. Ital. P. 128760,
 129687. I. Cuntz, F. P. 382411, 1907; F. and A. Lehner, U. S. P. 724020,
 1903, abst. J. S. C. I. 1903, **22**, 569. M. Muller, U. S. P. 836452, 1906; abst.
 J. S. C. I. 1907, **26**, 91; C. A. 1907, **1**, 502; E. P. 10094, 1906, abst. J. S. C. I.
 1906, **25**, 553; F. P. 365776, 1906, abst. J. S. C. I. 1906, **25**, 981; D. R. P.
 187947, abst. Zts. ang. Chem. 1908, **21**, 272; Chem. Tech. Rep. 1909, **31**,
 474; Chem. Ind. 1907, **30**, 452; Wag. Jahr. 1907, H. 397. Swiss P. 42300,
 1908, Aust. P. 33678, Belg. P. 191843, 1906. Can. P. 114815, 1908. Papier,
 Ztg. 1903, **28**, 1751, abst. Tech. J. Lit. 1903, **22**, 1095. Pmel Freres and
 A. Pmel, F. P. 400577, 1908, abst. J. S. C. I. 1909, **28**, 1031; Mon.
 Sci. 1911, (5), **74**, 153. Belg. P. 226272, 227062, 1910. D. Reid, U.
 S. P. 1117604, 1914, abst. C. A. 1915, **9**, 149; J. S. C. I. 1915, **34**,
 24; Zts. ang. Chem. 1915, **28**, Jan. 8. Soc. Anon. des Celluloses Planchon,
 E. P. 474727, 1913, abst. J. S. C. I. 1915, **34**, 1086. Soc. Anon. France-
 Kodak, E. P. 477735, 1915, abst. J. S. C. I. 1916, **35**, 597; U. S. P.
 1117604, 1914, abst. J. S. C. I. 1915, **34**, 21. Soc. Anon. Soie de St.
 Chamond, E. P. 24291, 1914; abst. J. S. C. I. 1915, **34**, 793; C. A. 1916, **10**,
 1600. E. P. 474777, 1913, abst. J. S. C. I. 1915, **34**, 1086. Soc. Anon.
 pour La Fabrication soie de Chardonnet, E. P. 1436, 1911; abst. C. A. 1911,
5, 3344; F. P. 430445, 1910. D. R. P. Ann. S. 33389, 1911, abst. Kunst. 1912,
2, 20. Swiss P. 51834, 1910. Soc. Anon. Francaise "La Soie Artificielle"
 F. P. 385083, 1907; abst. J. S. C. I. 1908, **27**, 558; First Add. dated April 29,
 1908 to F. P. 385083, 1907, abst. J. S. C. I. 1908, **27**, 1057. Soc. Franc. de la
 Viscose, E. P. 8045, 1906, abst. J. S. C. I. 1906, **25**, 753; C. A. 1907, **1**, 104,
 F. P. 361319, 1905; abst. J. S. C. I. 1906, **25**, 754; C. A. 1907, **1**, 1082; Belg.
 P. 189352, 191178, 1906. F. P. 394586, 1908; abst. J. S. C. I. 1909, **28**, 241.
 See also U. S. P. 970589, Swiss P. 43016. E. P. 21405, 1907 (S. Courtauld &
 Co.) E. P. 5595, 1908. D. R. P. 223736, 1907; abst. C. A. 1910, **4**, 3298; Belg. P.
 175866, 1906. Veremigte Glanzstoff Fabriken, E. P. 2992, 1913; abst. J. S.
 C. I. 1913, **32**, 907; C. A. 1913, **8**, 2620; F. P. 454011, 1913, abst. J. S. C. I. 1913
32, 865; Kunst. 1913, **3**, 356. See also U. S. P. 1102237, abst. J. S. C. I. 1914
33, 826. F. P. 4... 34, 467165, 1913, abst. J. S. C. I. 1915, **34**, 858; Kunst

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filaments, sheets or masses may be bleached,¹ dyed,² stabilized,³ toughened ("sthenosaged"),⁴ lustered,⁵ softened,⁶ waterproofed⁷

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 5. U. S. P. 1226178, 1917, abst. J. S. C. I. 1917, **36**, 707; C. A. 1917, **11**, 2155. F. Petit, F. P. 24376, 1913, abst. C. A. 1915, **9**, 1251; F. P. 461900, 1912; abst. C. A. 1914, **8**, 3373; J. S. C. I. 1914, **33**, 196; Chem. Ztg. 1913, **37**, 1527; Kunst. 1914, **4**, 172; F. P. 16764, Add. to F. P. 461900, abst. J. S. C. I. 1914, **33**, 858; Kunst. 1914, **4**, 310. Soc. France de la Viscose, U. S. P. 773412, 1904, (L. Naudin), abst. J. S. C. I. 1904, **23**, 1087; F. P. 340812, 1904; abst. J. S. C. I. 1904, **32**, 821; E. P. 5730, 1904; abst. J. S. C. I. 1905, **24**, 140; D. R. P. 175636, abst. Wag. Jahr. 1906, II, 390, Aust. P. 19037, Swiss P. 30322.
 6. L. Lilienfeld, U. S. P. 904269, 1908; abst. C. A. 1909, **3**, 721; J. S. C. I. 1908, **27**, 1202; E. P. 4597, 1906, abst. J. S. C. I. 1907, **26**, 140. U. S. P. 1037158, 1912. E. P. 26928, 1910. E. P. 14142, 1911; abst. J. S. C. I. 1912, **31**, 680. E. P. 1378, 1912; abst. J. S. C. I. 1913, **32**, 192; C. A. 1913, **7**, 2307; Kunst. 1913, **3**, 136; F. P. 439040, 1912; abst. J. S. C. I. 1912, **31**, 684. F. P. 438448, 1911; abst. J. S. C. I. 1912, **32**, 684. D. R. P. 250736, abst. Wag. Jahr. 1912, II, 505. C. A. 1912, **6**, 3531; Zts. ang. Chem. 1912, **25**, 2382; Kunst. 1912, **2**, 392; Aust. Appl. 244, 1910; abst. C. A. 1912, **6**, 1989; Chem. Ztg. Rep. 1911, **35**, 231. D. R. P. 254762, 1910; abst. Chem. Zentr. 1913, I, 34; D. R. P. Anm. L. 30438, 1910, abst. Kunst. 1912, **2**, 260. Aust. P. 49051; abst. Kunst. A. Pellerin, E. P. 15752, 1910; abst. J. S. C. I. 1911, **30**, 485; F. P. 417508, 1910; abst. J. S. C. I. 1911, **30**, 19; Kunst. 1911, **1**, 75. J. Subrenat, F. P. 328179, 1902; abst. J. S. C. I. 1904, **23**, 321. C. Waite, U. S. P. 690211, 1901; abst. J. S. C. I. 1902, **21**, 272. L. Wilson, U. S. P. 970589, 1910; abst. C. A. 1910, **4**, 3298. E. P. 21405, 1907; 5595, 1908; abst. J. S. C. I. 1908, **27**, 1057.
 7. Bolland et Cie, F. P. 473189, 1913; abst. J. S. C. I. 1915, **34**, 513. Bordas, Repept. Pharm. (3), **24**, 165; abst. C. A. 1912, **6**, 2460. J. Brandenberger, E. P. 20119, 1911. P. Lagrange, F. P. 463613, 1912; abst. J. S. C.

and finally dried.¹ Superficial xanthation² may also be resorted to. The waste lyes are purified³ and the polysulfide solutions regenerated.⁴

The most important commercial applications of these celluloses is in the preparation of artificial filaments, so-called "wood-silk," as competitors of the cuprammonium cellulose and nitrocellulose processes, and the mechanical ingenuity developed in this highly specialized art has been very great. These methods are based upon the patents of the Societe Francaise de la Viscose,⁵ S. Courtauld & Co.,⁶ C. Ernst,⁷ F. Steimmig,⁸ Vereinigte

I. 1914, **33**, 417; Kunst. 1914, **4**, 293. A. van Vriesland, E. P. 86, 1913; abst. J. S. C. I. 1913, **32**, 748; F. P. 452684; abst. Kunst. 1913, **3**, 475; D. R. P. 254870, 1912; C. A. 1913, **7**, 1810.

1. C. Waite, U. S. P. 689387, 1901; abst. Mon. Sci. 1902, (4), **58**, 78. U. S. P. 816404, 1906; abst. J. S. C. I. 1906, **25**, 426.

2. J. Ashwell, E. P. 19910, 1901; abst. J. S. C. I. 1902, **21**, 1393. F. P. 322557, 1902; abst. Mon. Sci. 1903, (4), **59**, 159. H. Aykroyd and P. Kraus, U. S. P. 657840, 1900; Belg. P. 146685, 1899; abst. Chem. Ztg. 1900, **24**, 748, 840; F. P. 295359, 1899; abst. Mon. Sci. 1901, (4), **57**, 42. Belg. P. 146770, 1899. P. Jolait, E. P. 1572, 1915; abst. C. A. 1916, **10**, 2044. F. P. 468380; First Add. Aug. 4, 1913; abst. Kunst. 1914, **4**, 311; C. A. 1915, **9**, 2317; J. S. C. I. 1914, **33**, 958; 1915, **34**, 488. F. P. 470141, 1914; abst. Kunst. 1915, **5**, 56; J. S. C. I. 1915, **34**, 25.

3. W. Brachter, F. P. 464730, 1913; abst. J. S. C. I. 1914, **33**, 480. P. Kraus, U. S. P. 1035882, 1912. N. Langlet, F. P. 406744, 1909; La Soie Artificielle Soc. Anon. France, E. P. 1573, 1912; abst. C. A. 1913, **7**, 2472; J. S. C. I. 1912, **31**, 431; F. P. 449457, 1911; abst. J. S. C. I. 1913, **32**, 483. D. R. P. Ann. S 35402, 1912; abst. Kunst. 1912, **2**, 260. D. R. P. 252179, 1912; abst. Kunst. 1912, **2**, 399; Wag. Jahr. 1912, II, 442; C. A. 1912, **6**, 416; Zts. ang. Chem. 1912, **25**, 2382. Holl. P. 110, 1914; abst. C. A. 1914, **8**, 2482. R. Linkmeyer & M. Pollak, Swiss P. 40614, 1907. E. Rinman, D. R. P. 231254, 1910; Add. to D. R. P. 222302, 1909; abst. J. S. C. I. 1911, **30**, 485; Zts. ang. Chem. 1911, **24**, 478; Chem. Zentr. 1911, I, 700; E. P. 8175, 1909; abst. J. S. C. I. 1910, **29**, 18; F. P. 401856, 1909; abst. J. S. C. I. 1909, **28**, 1163. L. Wallach, E. P. 18312, 1907; abst. J. Soc. Dyers and Col. 1908, **24**, 141.

4. A. Soc. Franc. de la Viscose, F. P. 332636, 1903; abst. J. S. C. I. 1904, **23**, 75; F. P. 334515, 1903; abst. J. S. C. I. 1904, **23**, 75; see also G. v. Henckel-Donnersmarck, D. R. P. 152743, E. P. 16604, 1903; Aust. P. 16112, L. Wilson, U. S. P. 1106266; abst. C. A. 1914, **8**, 3639.

5. U. S. P. 923777, 1909; abst. J. S. C. I. 1909, **28**, 702; F. P. 377424, 1906; abst. J. S. C. I. 1907, **26**, 1077; D. R. P. 192406, Aust. P. 34101, E. P. 17152, 1904; abst. J. S. C. I. 1905, **24**, 798; F. P. 345274, 1904; abst. J. S. C. I. 1904, **23**, 1212; D. R. P. 164321. E. P. 19157, 19158, 1908; abst. J. S. C. I. 1909, **28**, 880; F. P. 406344; D. R. P. 236242; see also J. Clayton and S. Courtauld U. S. P. 979434. F. P. 345293, 345320, 1904; abst. J. S. C. I. 1904, **23**, 1212; D. R. P. 163467, F. P. 345373, 1904; abst. Zts. ang. Chem. 1905, **18**, 434, F. P. 361877, 1905; abst. J. S. C. I. 1907, **26**, 17; Swiss P. 38455, F. P. 421900, 1910; abst. J. S. C. I. 1911, **30**, 532; Kunst. 1911, **1**, 276. Belg. P. 178715, 178733, 178766, 178775, 178792, 1904. Can. P. 120763, 1909.

6. E. P. 19157, 19158, 1908. E. P. 104363, 1917, Belg. P. 238869, 1911; abst. Chem. Ztg.; Swiss. P. 57506; abst. Kunst. 1913, **3**, 176. Aust. Ann. A. 4422, 1909. Ital. P. 369/240/120481, 1911; abst. Chem. Ztg. 1912, **36**, 174.

¹ Kunstseide Fabr.,¹ A. Pellerin,² J. Criggal,³ J. Hartogs,⁴ and others.⁵ Various methods for twisting,⁶ tension equalization⁷.

Belg. P. 210816, 1908 (Courtaulds, Ltd and L. Wilson) Courtaulds, Ltd. and Criggal, E. P. Appl. 12513, 1918; abst. J. S. C. I. 1918, **37**, A, 491.

7. U. S. P. 792888, 1905; abst. J. S. C. I. 1905, **34**, 799. U. S. P. 798027, 1905; abst. J. S. C. I. 1905, **24**, 966. U. S. P. 898148, 808149, 1905; abst. J. S. C. I. 1906, **25**, 120. 863793, 1906; abst. J. S. C. I. 1907, **26**, 1004. 876533, 896715, 1908; abst. J. S. C. I. 1908, **27**, 977. C. Waite, U. S. P. 759332, 1904; abst. J. S. C. I. 1904, **23**, 620, 816404, 1906; abst. J. S. C. I. 1906, **25**, 426.

8. E. P. 11104, 1913; abst. J. S. C. I. 1914, **33**, 132. F. P. 458970, 1913; abst. J. S. C. I. 1913, **32**, 1153. Kunst. 1914, **4**, 16. C. A. 1914, **8**, 3373; U. S. P. 1200774, 1916; abst. C. A. 1916, **10**, 3160. D. R. P. Ann. St. 8230, 1913; abst. Kunst. 1913, **3**, 300. Belg. P. 257589; abst. Kunst. 1914, **4**, 155. Swiss P. 641919, 1913; abst. Kunst. 1914, **4**, 370. It. P. 131704; abst. Chem. Ztg. Rep. 1913, **37**, 1433. (See also U. R. P. 70999, 152743, 153817.) U. S. P. 6238, 1914; abst. Kunst. 1911, **4**, 359, 479. C. A. 1915, **9**, 2315. J. S. C. I. 1914, **33**, 688. D. R. P. Ann. St. 18230, St. 18576, 1913. Ver. Kunstseide-fabr. E. P. 17501, 1902; D. R. P. 155745; abst. Jahr. Chem. 1904, 1163; Wag. Jahr. 1904, II, 389. Aust. P. 20107, E. P. 17502, 1902; D. R. P. 183623, 1902; abst. C. A. 1908, **2**, 345. Zts. ang. Chem. 1907, **20**, 1542; Chem. Zentr. 1907, II, 1034. Jahr. Chem. 1905, 98, 988. Wag. Jahr. 1907, II, 396; Mon. Sci. 1909, (4), **70**, 168. F. P. 323473.

1. U. S. P. 724020, E. P. 17503, 1902; abst. J. S. C. I. 1903, **22**, 879. F. P. 323474, 1902; abst. J. S. C. I. 1903, **22**, 508. Mon. Sci. 1909, (4), **59**, 198. D. R. P. Ann. V. 10382, 1912; abst. Kunst. 1912, **2**, 319. V. 10176, 1911; abst. Kunst. 1912, **2**, 319. Aust. P. Ann. A. 23712, 1911; abst. Kunst. 1912, **2**, 460. Glanzfaden Akt. Ges., E. P. 135205, 141041; D. R. P. 312304; abst. J. S. C. I. 1920, **39**, 13-A. C. A. 1920, **14**, 2367.

2. U. S. P. 1128624; abst. C. A. 1915, **9**, 1114. See D. R. P. 271215, 1913; abst. C. A. 1914, **8**, 2491. Swiss P. 64190, 1913; abst. C. A. 1914, **8**, 2982. E. P. 7748, 1910; E. P. 121734, F. P. 410776, 1909; abst. J. S. C. I. 1910, **29**, 811; 466292, 1913; abst. C. A. 1915, **9**, 1396. J. S. C. I. 1914, **33**, 589; Kunst. 1914, **4**, 256. D. R. P. Ann. P. 25252, 1910; abst. Kunst. 1912, **2**, 379. Aust. P. Ann. A. 10081, 1910; abst. Kunst. 1912, **2**, 320. Aust. P. 55749; abst. Kunst. 1913, **3**, 53. Swiss P. 54616, 1911.

3. E. P. 18965, 1912.

4. E. P. 16720, 1911.

5. Bardy, F. P. 314551, 1901. V. Catala, F. P. 430876, 1911; abst. Kunst. 1913, **2**, 33. M. Denis, Belg. P. 250219; abst. Kunst. 1914, **4**, 237. H. Hennebutte and A. Monse, Belg. P. 180585, 1904. J. Luxberg, E. P. 1407, 1909. Gocher-Oelmühle Gebr. von den Bosch, F. P. 373887, 1907; Swiss P. 30711, E. P. 3606, 1907. Aust. P. 36922 (Reichsische Kunst. Fab.) F. Petit, E. P. 28225, 1912. Sociedad Espanol de Seda Viscose, Span. P. 51810, 1911. Chem. Ztg. 1912, **36**, 339. Span. P. 51813, 1912. Soc. Soie Artificielle du Nord und P. Villain, Belg. P. 262367; abst. Kunst. 1914, **4**, 319. F. P. 465322, 1907; abst. Kunst. 1914, **4**, 319; F. P. 18730, Add. to F. P. 465322. Socie. Suisse de la Viscose, Swiss P. 55411, 1911. K. Sivern and F. Mach, Farber Ztg. 1903, **14**, (4), 54; abst. J. S. C. I. 1903, **22**, 360. Wag. Jahr. 1903, II, 416; Jahr. Chem. 1903, 1560. Chem. Zentr. 1903, I, 742. The T. V. have method of spinning artificial silk from viscose, is described in Holl. P. 3352, 1919; abst. C. A. 1920, **14**, 1901.

6. G. Donnersmarck, D. R. P. 152743, 1903; abst. Chem. Zentr. 1904, II, 381. Jahr. Chem. 1904, 1169. Aust. P. 16112, F. P. 334515; see also C. Stearn, E. P. 16604, 1903; abst. J. S. C. I. 1904, **23**, 784. D. R. P. 152817, Add. to D. R. P. 152743; abst. Jahr. Chem. 1904, 1169; Wag. Jahr. 1904, II, 390; Chem. Zentr. 1904, II, 928. D. R. P. 189140, 1903; abst. Wag. Jahr.

and control of solutions¹ have been described. Considerable attention has been devoted to endeavors to prepare stable viscose in a dry form.² In addition to the formation of artificial filaments, other applications of viscose are numerous.³ In the manufacture of films, many difficulties, primarily mechanical, have had to be overcome, especially in the preparation of continuous photo films. The processes of E. Brandenberger,⁴ and to a lesser degree the methods of C. Ernst,⁵ Heyden,⁶ Flusin⁷ and (1907, II, 398; Chem. Zentr. 1907, II, 1815; Chem. Tech. Rep. 1907, **30**, 504; Chem. Ind. 1907, **30**, 534; Mon. Sci. 1910, (4), **72**, 77; D. R. P. 212954, 1907; abst. C. A. 1910, **4**, 252; Chem. Zentr. 1909, II, 948; Chem. Ind. 1909, **12**, 601; Chem. Zts. 1910, **9**, 1594; Jahr. Chem. 1909, 391; F. P. 398424; Z. P. 1407, 1909 (G. Luxberg); Swiss P. 47395.

7. Kichner, Chem. Ztg. 1898, **22**, 719. Soc. Francaise de la Viscose, F. P. 377424, 1906; abst. J. S. C. I. 1907, **26**, 1087; U. S. P. 923777, 1909; Belg. P. 201132, 1907; D. R. P. 192406; Aust. P. 34101.

1. C. Topham, U. S. P. 702382; 1902; abst. J. S. C. I. 1902, **21**, 969; E. P. 23157, 1900; 5766, 1905; abst. J. S. C. I. 1906, **25**, 333; Aust. P. 25175. F. P. 309541, 1901; D. R. P. 125947, 127046; Swiss P. 24301; Aust. P. 9548. G. Lequeux, F. P. 415619, 1910; Swiss P. 57256, 1911.

2. H. Lyncke, U. S. P. 1074881, 1913; abst. C. A. 1913, **7**, 4063, 4068; J. C. C. F. 1918, **32**, 1006; Chem. Ztg. Rep. 1913, **37**, 1365; Mon. Sci. 1914, **39**, E. P. 8023, 1908; abst. J. S. C. I. 1908, **27**, 996; C. A. 1909, **3**, 714; F. P. 388915, 1908; abst. J. S. C. I. 1908, **27**, 956; Mon. Sci. 1909, (4), **70**, 111; C. A. 1909, **2**, 2382; D. R. P. 237261, 1907; abst. C. A. 1912, **6**, 1526; Zts. ang. Chem. 1911, **24**, 1837; Chem. Zentr. 1911, II, 408; Kunst. 1911, **1**, 338. Aust. P. Ann. 2900, 1909; abst. Kunst. 1912, **2**, 319. See E. Kayser, Zts. Farb. u. Text. Chem. 1902, **1**, 575; C. Kurz, Zts. Farb. u. Text. Chem. 1902, **1**, 46. According to R. Linkmeyer (D. R. P. 312392, 1917; abst. J. S. C. I. 1920, **39**, 227-A) viscose solutions are treated with substances which contain amide or imide groups or are capable of forming such groups. Suitable substances are: Urea, derivatives of urea, cyanamide, dicyanodiamide, guanidine and its derivatives, acid amides, urethane, cyanates, thiourea, mustard oils, and condensation products of the above substances with aldoses. The viscose solutions are thereby rendered more stable and remain suitable for spinning for several weeks; the threads are characterized by good strength, are sensitive to the action of water when they have been precipitated in a coagulating bath containing formaldehyde.

3. U. S. P. 1049658; abst. Kunst. 1913, **3**, 276; J. S. C. I. 1913, **32**, 133. E. P. 4068, 1912; abst. J. S. C. I. 1912, **31**, 1119. E. P. 22022, 1897. E. P. 20119, 1911; abst. C. A. 1913, **7**, 886; Kunst. 1912, **2**, 476; J. S. C. I. 1912, **31**, 770; F. P. 434104, 1910; abst. J. S. C. I. 1912, **31**, 225; Kunst. 1912, **2**, 157. E. P. 3929, 4064, 4065, 1912. F. P. 436186, 1911. D. R. P. 237152, abst. Wag. Jahr. 1911, II, 506; C. A. 1912, **5**, 1990; Zts. ang. Chem. 1911, **24**, 1838; Kunst. 1911, **1**, 340. D. R. P. 257227, 1910; abst. Kunst. 1913, **3**, 100 215; Chem. Zentr. 1913, I, 1079. D. R. P. Ann. B. 54778, 1909, B. 54749, 1909, B. 60863, 1910. Aust. P. 46543, 1910, 58375, 1912, 61602; abst. Kunst. 1914, **4**, 56. 64564, abst. Kunst. 1914, **4**, 238.

4. Aust. P. 54483; abst. Kunst. 1913, **3**, 37.

5. U. S. P. 863793, 1907.

6. Moll. P. 743, 1913. Chemische Fabrik v. Heyden A. G., D. R. Ann. C. 19968, 1911, and addn. C. 20522, Belg. P. 250077, 1912.

7. Ann. Chim. Phys. 1908, (8), **13**, 480; abst. Chem. Zentr. 1908, I 1914.

the Vereinigte Glanzstoff Fab.¹ are representative of the development in this field of viscose technics. In those films designed, especially for photography, J. Chorley,² D. Reid,³ and the Societe des Etablissements Gaumont⁴ have devised meritorious methods. The viscose sheets of C. Stearn and F. Woodley,⁵ B. Borzykowski,⁶ and especially of E. Brandenberger,⁷ deserve mention. The product of the latter inventor, under the name of "Cellophane," has found wide application as a wrapping material for the protec-

1. F. P. 454011, 1913; abst. Rev. gen. Mat. Col. 1913, 21.
2. J. Chorley, U. S. P. 634571, 1899, 641023, 1900; 689337, 1901. E. P. 18607, 1898; abst. J. S. C. I. 1899, 12, 703. Belg. P. 141875, 1899.
3. D. Reid, U. S. P. 111607, 1914; abst. C. A. 1915, 9, 120. * See also C. A. 1914, 8, 2124.
4. E. P. 3198, 1915; abst. C. A. 1917, 11, 2077.
5. U. S. P. 725016, 1903; abst. J. S. C. I. 1903, 22, 509; E. P. 2520, 1902; abst. J. S. C. I. 1903, 22, 509. F. P. 1020, 1021, 1022, 1898; Can. P. 83099, 1903.
6. B. Borzykowski, F. P. 420555, Belg. P. 220404, Span. P. 48887; Ital. P. 112260, Swiss P. 54146, 1911. For other Borzykowski Patents see Cupro-oxy ammonium cellulose solution, U. S. P. 1100518, Belg. P. 251118, E. P. 24996, 1912; F. P. 450193, Ital. P. 129256, Russ. P. 54968, Span. P. 54237. Dyed cellulose ester, U. S. P. 1041587, Belg. P. 246502, F. P. 444568, Ital. P. 125696; Aust. P. 60039, Hung. P. 58767, Russ. P. 26112, Swiss P. 60510, D. R. P. 262253. Spinning Machine Belg. P. 220407, F. P. 420082; Ital. P. 112451; Hung. P. 52393, Russ. P. 22940, Swiss P. 53749, Span. P. 48911, D. R. P. 248349. Viscosc, U. S. P. 1143509, Belg. P. 257325; E. P. 12000, 1913; F. P. 459125; Ital. P. 133989; Hung. P. 11539, 1913; Swiss P. 64900. Articles from Viscose U. S. P. 1260508, E. P. 4601, 1913. Artificial bristles, U. S. P. 1010222, Belg. P. 232255, E. P. 30398, 1910, F. P. 424428, Ital. P. 115139; Swiss P. 50707, Span. P. 49719. Dull Cellulose products, D. R. P. 262253. Substitute for glass, Belg. P. 220404, F. P. 420555, Ital. P. 112260, Hung. P. 55647, Swiss P. 54146, Span. P. 48887. Apparatus for production of films, U. S. P. 1000679, F. P. 454692, D. R. P. 281424.
7. U. S. P. 981368; abst. (C. A. 1911, 5, 1188) J. S. C. I. 1911, 30, 126. E. P. 15190, 1909; abst. J. S. C. I. 1910, 29, 147. U. S. P. 984886, abst. C. A. 1911, 5, 1564; J. S. C. I. 1911, 30, 385; E. P. 13328, 1909; abst. C. A. 1915, 9, 3037; J. S. C. I. 1909, 28, 1223; F. P. 413900, 1909; abst. J. S. C. I. 1910, 29, 1135; D. R. P. 230558, 1909; abst. C. A. 1911, 5, 2600; J. S. C. I. 1911, 30, 385; Zts. ang. Chem. 1911, 24, 475; Cherg. Zentr. 1911, I, 444; Wag. Jahr. 1911, II, 556. U. S. P. 991267, abst. J. S. C. I. 1911, 30, 679; E. P. 15190, 1909; J. S. C. I. 1910, 29, 147; U. S. P. 1002634, abst. J. S. C. I. 1911, 30, 1156; E. P. 15281, 1909; abst. J. S. C. I. 1910, 29, 83. U. S. P. 1266760, 1918; abst. J. S. C. I. 1918, 37, A, 402; F. P. 458038, 1913; abst. J. S. C. I. 1913, 32, 1063; E. P. 13072, 1914; abst. J. S. C. I. 1915, 24, 606. F. P. 414518, 1909; 414504; 470267, 1914. D. R. P. 249256, 1911; abst. Kunst. 1912, 2, 334; C. A. 1912, 6, 3518; F. P. 438775. Swiss P. 58729, 58730, 1911. Apoth. Ztg. 1911, 306; Und les Nouv. Remed. 1912, No. 15. Cosmos 1913, 69, 705. N. Y. Times, March 11, 1915. Kunst. 1914, 4, 40. Muellex. Chem. Ztg. 37, 404; abst. J. Ind. Eng. Chem. 1913, 5, 515. For data on Cellophane, see Apoth. Ztg. 1911, 206; Nouv. Remed. 1912, No. 15. J. Galopin (Rev. Sci. 1919, 57, 398; abst. C. A. 1919, 13, 2490) has described the formation of graphic diapositives on Cellophane. E. Cervenka (Cz. P. 187459, 1918) has described a process of color photography, using Cellophane.

tion of packages, and in the hydrated state for the capping of bottles, advantage being taken of the high contractility of the viscose when moist. Flexoloid, Biophane, Dramantine, Brilliantine and Visca are commercial names for similar products.

In the formation of viscid masses, the methods of C. Beadle,¹ C. Cross and Viscose Development Co.,² G. Huebner,³ M. Olivier,⁴ and L. Lefevre,⁵ together with the "Cellulith" of S. Ferenczi,⁶ are typical. For hollow articles, the processes of E. Thomas,⁷ A. Plisson,⁸ Courtaulds, Ltd., and L. Wilson,⁹ R. Wagner and C. v. Radinger,¹⁰ and E. Thorhas and J. Bonavita¹¹ are illustrative. G. Stearns¹² and Boullier¹³ have proposed to utilize viscose for incandescent electric lamp filaments. The proposal of B. Lach¹⁴

1. J. Frank. Inst. 1894, **138**, 100; abst. Chem. Trade J. 1894, 128; Tech. Rep. 1894, 38; Jahr. Chem. 1894, 1134; J. Frank. Inst. 1897, **143**, 1; abst. C. N. 1897, **75**, 74, 86; Chem. Centr. 1897, I, 572, Jahr. Chem. 1897, 1506. See also Portolac Holzmasse, F. P. 444184, 1912; Belg. P. 245181, 1912; Aust. P. 64798; abst. Kunst. 1914, **4**, 257; Swiss P. 64940, 1913; Holl. P. 782, 1916; abst. C. A. 1917, **11**, 539.
2. E. F. 116366, 1917; abst. J. S. C. I. 1918, **37**, A-461, C. A. 1919, **12**, 73.
3. D. R. P. 82112; abst. Wag. Jahr. 1895, 288.
4. U. S. P. 826351, 1906; abst. J. S. C. I. 1906, **25**, 821. Can. P. 99505, 1909; Erste Oesterr. Soda Fabrik, Aust. P. 968, 1899.
5. Rev. Gen. Mat. Colorantes, 1898 (Feb.); Monat. fur Text. Ind. (2), **13**, 959; abst. J. S. C. I. 1898, **17**, 573.
6. Zts. ang. Chem. 1899, 51; abst. Chem. Centr. 1899, I, 573. P. Defaucamberge, U. S. P. 943658, 1909. See also M. Oliver, U. S. P. 826351, 1906. See M. Oliver and E. Thomas, "La Viscose," Paris 1900; J. Bonavita, La Nature, 1900, 250.
7. E. P. 11663, 1900; abst. J. S. C. I. 1901, **20**, 741; 11664, 1900; abst. J. S. C. I. 1901, **20**, 741; F. P. 302808, 1900; abst. Mon. Sci. 1901, (4), **57**, 141. D. R. P. 125416; abst. Wag. Jahr. 1902, II, 596. Aust. P. 4767, 1900, 5711, 1901, Chem. Ztg. 1900, **24**, 686. See also Thomas and Provost, D. R. P. 129883, 1900.
8. E. P. 23589, 1911.
9. U. S. P. 1175857, 1916; abst. C. A. 1916, **10**, 1434; E. P. 17495, 1914; abst. J. S. C. I. 1915, **34**, 901.
10. E. P. 9240, 1909.
11. E. P. 11663, 11664, 1900. See also Thonias and Provost, D. R. P. 129883, 1900.
12. U. S. P. 622087, 1899; E. P. 1020, 1021, 1898; abst. J. S. C. I. 1899, **18**, 25. Swiss P. 19135, D. R. P. 108511. Belg. P. 169443, 1903.
13. C. Boehm, Die Fab. der Glühkörper für Gasglühlicht. 1910, 72. H. Bresler (U. S. P. 1023295, 1915; abst. J. S. C. I. 1912, **31**, 482) prepares incandescent filaments, the finely divided metal, such as tungsten, being held in a binder of ammonium viscose. Boullier, F. P. 319217, 1902; abst. J. S. C. I. 1902, **21**, 1448. E. Knoedler (Met. Chem. Eng. 1916, **15**, 635; abst. J. S. C. I. 1917, **36**, 26), and F. Planchon (E. P. 4956, 1908) employ viscose for the same purpose.
14. E. P. 6031, 1912; 15324, 1912; abst. J. S. C. I. 1912, **31**, 1079. See also W. Thompson, E. P. 5061, 1898.

for the manufacture of artificial wood from viscose, has not as yet been commercialized. Under the names of "Decapant" and "Crysol," viscose has been advocated as an efficient evaporative, inhibiting solvent paint remover.

An important field for viscose has developed in the dressing and finishing of fabrics, and in rendering permanent embossed effects on woven goods. Many valuable and novel applications for viscose in this field have been disclosed in the ideas of L. Lilienfeld,¹ Vereinigte Kunstseidefabriken,² A. Fielding,³ J. Sackville,⁴ C. Tredup,⁵ R. Haller,⁶ Soc. Franc de la Viscose,⁷

1. U. S. P. 815600, 1906; abst. J. S. C. I. 1906, **25**, 372; F. P. 417392, 1910; abst. J. S. C. I. 1911, **30**, 36; F. P. 6635, 1902; abst. J. S. C. I. 1903, **22**, 694. U. S. P. 834739, 1906; abst. J. S. C. I. 1906, **25**, 1143; F. P. 14463, 1902; abst. J. S. C. I. 1903, **22**, 1345; D. R. P. 182773, 1903; abst. J. S. C. I. 1903, **22**, 694. U. S. P. 960100, 1910; abst. J. S. C. I. 1910, **29**, 812; E. P. 2998, 1907; abst. J. S. C. I. 1908, **27**, 279; J. S. P. 1036282, 1912; abst. J. S. C. I. 1912, **31**, 873; C. A. 1912, **6**, 3543; F. P. 438087, 1911; abst. J. S. C. I. 1912, **31**, 383; E. P. 25245, 1911; abst. J. S. C. I. 1912, **31**, 813; C. A. 1913, **7**, 1616; E. P. 7317, 1914; Addn. to E. P. 25245, 1911; abst. C. A. 1915, **9**, 2455. E. P. 5214, 1905; abst. J. S. C. I. 1906, **25**, 263. E. P. 8708, 1908; 15306, 1909; abst. J. S. C. I. 1910, **29**, 1005. E. P. 1378, 1912; abst. C. A. 1913, **7**, 2307. See also E. P. 4713, 1896. Swiss P. 06512, abst. Kunst. 1915, **5**, 82. Aust. P. 848, 1909; abst. Mon. Ser. 1913, **78**, 96; Aust. 51174, 1911. E. P. 14339, 1911; abst. C. A. 1915, **9**, 3359. F. P. 430040, 1912; abst. J. S. C. I. 1912, **31**, 584; D. R. P. Ann. I. 30420, 1910. D. R. P. 255302, 1911; abst. Chem. Zentr. 1913, I, 341; D. R. P. 257459, 1912; abst. Chem. Zentr. 1913, I, 1244. Aust. Ann. A. 8809, 1910; abst. Kunst. 1912, **2**, 340.
2. E. P. 17501, 1902; abst. J. S. C. I. 1903, **22**, 817; F. P. 323475, 1902; abst. J. S. C. I. 1903, **22**, 508. D. R. P. 155745, 1902; abst. Chem. Zentr. 1904, II, 1678; Aust. P. 29407. D. R. P. 125309, 129436, 1900. Belg. P. 164907, 164908, 1902. Belg. P. 207484, 1908, 252405; abst. Kunst. 1913, **3**, 357. Swiss P. 58883, 1911, 59380, 1912. See Silkin Kunstseide Industrie Ges., Hung. Ann. S-6451, Aust. P. Ann. 7840, 1912.
3. U. S. P. 708761, 1902; abst. J. S. C. I. 1902, **21**, 1230; F. P. 320748, 1902; abst. J. S. C. I. 1903, **22**, 25. See also U. S. P. 520770, 1904; E. P. 8700, 1892; abst. J. S. C. I. 1893, **12**, 517. E. P. 9849, 1903; abst. J. Soc. Dyers and Col. 1904, **20**, 123. J. Ost., D. R. P. 211267, 1907; abst. C. A. 1909, **2**, 2638; 211735, 1908. Addn. to D. R. P. 211267, 1907; abst. C. A. 1909, **2**, 2638; Zts. ang. Chem. 1909, **22**, 1559; Chem. Zentr. 1909, II, 403; Chem. Tech. Rep. 1909, **33**, 404; Wag. Jahr. 1909, II, 258.
4. U. S. P. 1087638, 1914; abst. J. S. C. I. 1914, **33**, 350; C. A. 1914, **8**, 1512; E. P. 15080, 1912; abst. J. S. C. I. 1913, **32**, 284; J. Soc. Dyers and Col. 1913, **29**, 175. F. P. 454826, 1913; abst. J. S. C. I. 1913, **32**, 860; C. A. 1914, **8**, 1017; Farb. Ztg. 1914, 63, 69. Heilmann & Co., A. Lipp and M. Battagay, Bull. Soc. Ind. Mulhouse, **51**, 137; abst. C. A. 1911, **5**, 3913. (See also L. Lilienfeld, C. A. 1911, **5**, 2737.) N. Katz, U. S. P. 1251237, 1917; abst. J. S. C. I. 1918, **37**, 146-A. A. Kilner, E. P. 15761, 1914; abst. J. S. C. I. 1915, **34**, 830. (See also E. P. 17253, 1900, 9849, 1903, 22371, 1910, 21426, 1912, 6798, 1912; abst. J. S. C. I. 1901, **20**, 597, 1904, **23**, 439; 1912, **31**, 1026, 1027.) J. Sackville, E. P. 18022, 1902; 9073, 1911; abst. J. S. C. I. 1903, **22**, 1056; 1912, **31**, 532. U. S. P. 724616, 1903.
5. U. S. P. 918397, 1909.
6. Zts. Farben. Text. Ind. 1904, 81; abst. Wag. Jahr. 1904, II, 471;

L. Lefevre,¹ and others.² M. Puaux³ has proposed to print and fix reserve colors on aniline black by means of viscose, while G. Nakamura has proposed a substitute for hemp of the same material.⁴ As a sizing for paper and general adhesive, the cellulose xanthates have found many uses as described in the patents of L. Lilienfeld,⁵ C. Beadle,⁶ A. Little,⁷ A. Fielding,⁸ A. Küner,⁹ Chem. Centr. 1904, I, 1040.

7. U. S. P. 912812, 1909; abst. J. S. C. I. 1909, **23**, 301; F. P. 335598, 1903; abst. J. S. C. I. 1904, **23**, 251.

1. Rev. Gen. Mat. Col. 1898, Feb.; abst. Monatsh. (3), **13**, 159; abst. J. S. C. I. 1898, **17**, 573.

2. B. Borzykowski, F. P. 463400, 1913; abst. C. A. 1914, **8**, 3373. A. Binz, Zts. ang. Chem. 1898, **11**, 595. A. Buntrock, Rev. Gen. Mat. 1898, **2**, 345; abst. J. S. C. I. 1899, **18**, 37. P. Pometts, 1897, **8**, 876; Ztg. ang. Chem. 1898, **11**, 981. E. Brandenberger, U. S. P. 1002634, 1911; abst. J. S. C. I. 1911, **30**, 1156; E. P. 15281, 1909; abst. J. S. C. I. 1910, **29**, 83. D. R. P. 231265, 1905; abst. C. A. 1912, **6**, 1853. Saget, L'Industria Tex. 1909, 234; abst. J. Soc. Dyers Col. 1909, **25**, 245. G. Winterbottom and J. Egerton, E. P. 12687, 1909. See also F. Smith and C. Macintosh & Co., E. P. 26695, 1896. Färb. Ztg. 1905, **54**, 404; abst. Zts. ang. Chem. 1905, **18**, 1990. For Viscose filament forming heads refer to M. Waddell, U. S. P. 923009, 1906; E. P. 7690, 1908. Soc. France de la Viscose, F. P. 345343, 1904; abst. J. S. C. I. 1904, **23**, 1212; D. R. P. 160244, Zts. ang. Chem. 1905, 434; J. S. C. I. 1904, **23**, 1212. Ernst, U. S. P. 858648. J. Aubrehat, F. P. 328179, 1902; abst. Zeit. Farb. Text. Ind. 1904, **3**, 113. For critical review of this process see Zeit. Farb. Text. Ind. 1904, **3**, 134. C. Weber, Gum. Ztg. 1899, **14**, 49; Zts. ang. Chem. 1899, **12**, 5; J. Wolff, Rev. d. Chim. Ind. 1896, p. 251; Gum. Ztg. 1897, **12**, 164; 1903, **28**, 283; Text. Mfr. 1903, **29**, 283; Leip. Färb. Ztg. 1905, **54**, 402. A. Fielding, U. S. P. 708761, 1902; E. P. 20396, 1901; E. P. 9849, 1903; See O. Witt and A. Buntrock, Dingl. Poly. 1895, **295**, 233; Osterr. Wollen u. Leinen Ind. 1899, p. 11. L. Geveart-Naert, E. P. 17253, 1900; 8381, 1907. D. R. P. 127422, 1900. U. S. P. 719787, 1903. Belg. P. 149071, 150905, 1900. Can. P. 77698. In this connection see E. Noelting, Chem. Ztg. 1902, **26**, 298, C. Kurz, Zeit. Farb. Text. Chem. 1902, **1**, 48, E. Kayser, Ibid. 1902, **1**, 575. For Viscose as a mordant, see Fielding, E. P. 20398, 1901, L. Lilienfeld, E. P. 15306, 1909; U. S. P. 960100, 1910. Oldroyd and Blakeley, First Addition dated April 24, 1907, to F. P. 333835, 1903; J. S. C. I. 1904, **23**, 17; U. S. P. 724616, 1903, E. P. 19912, 1901. The process of H. Akroyd and P. Krais, (Belg. P. 146685, 1899; U. S. P. 657849, 1900; Chem. Ztg. 1900, **24**, 748, 849) is very similar.

3. M. Puaux, sealed letter No. 1094, Mar. 8, 1899; Bull. Soc. Ind. Mulhouse, **88**, 281 and report by F. Noelting, Ibid. 283; abst. C. A. 1911, **5**, 787.

4. G. Nakamura, Jap. P. 31991, 1918; abst. C. A. 1918, **12**, 2258.

5. E. P. 26928, 1910; 7317, 14339, 1914. F. P. 439040, 1912; abst. J. S. C. I. 1912, **31**, 584; E. P. 1378, 1912; abst. J. S. C. I. 1913, **32**, 192. D. R. P. 291043, 1910; abst. C. A. 1911, **5**, 2737; 1912, **6**, 685; Zts. ang. Chem. 1911, **24**, 575; Chem. Zentr. 1911, I, 766; Wag. Jahr. 1911, II, 467. D. R. P. 254762, abst. Wag. Jahr. 1912, II, 504; C. A. 1913, **7**, 1110. D. R. P. 255302, 1911; abst. C. A. 1913, **7**, 1619; Wag. Jahr. 1912, II, 504. D. R. P. 257469, 1912; abst. C. A. 1913, **7**, 2489. D. R. P. Ann. L. 33378, 1911; abst. Kunst. 1912, **2**, 379. L. Lilienfeld and Tedesko, E. P. 5214, 1906; abst. J. S. C. I. 1906, **25**, 263.

6. U. S. P. 569704, 1896, Chem. News, 1906, 127; abst. J. Soc. Dyers and Col. 1906, **22**, 381; Chem. Zentr. 1906, II, 1886; C. A. 1907, **1**, 356; Re-

and others.¹ Phonograph plates,² artificial feathers,³ sponge,⁴ cork,⁵ and especially artificial leather have been described in which viscose was a predominant constituent. The viscose leather substitutes as developed by L. Lilienfeld,⁶ and L. Geveart-Naert⁷ are illustrative.

Many attempts have been made to produce viscose plastics by the addition of thermoplastic agents producing results analogous to the thermoplasticity imparted to the cellulose nitrates by means of camphor, but as yet without entirely satis-

- print Chem. Eng. 1900, **5**, 9. See Chem. News, 1897, **75**, 74. J. Frank. Inst. 1894, **138**, 100, 1897, **143**, 1; C. Levy, Annuario Societa Chimica Milano 1905, **10**, 233; Haber, Dingt. Poly. 1894, **234**, 210. See also Farleder, Papier Ztg. 1897, **22**, 3396.
7. U. S. P. 691951, 691952, 1902, abst. J. S. C. I. 1902, **21**, 302. J. Frank. Inst. 1894, **138**, 111, abt. J. S. C. I. 1895, **14**, 59.
8. U. S. P. 708761, 708760, 1902, P. P. 26397, 26398, 1901; P. P. 320478, 1902; E. P. 2323, 1904, abst. J. S. C. I. 1905, **24**, 40; F. P. 350910, 1905, abst. C. A. 1907, **1**, 130. See also A. Little, J. Frank Inst. 1894, **138**, 114; abst. J. S. C. I. 1893, **12**, 498, 1894, **13**, 900; 1895, **14**, 59; Text. Mfg. 1900, **26**, 322, v. Possanner, W. Papierfabr. 1908, 604, 1221; F. Arleder, Papier Ztg. 1897, 3396.
9. E. P. 14111, 1914, abst. C. A. 1915, **9**, 3350; E. P. 15761, 1913; See also E. P. 17253, 1900, 9849, 1903, 22311, 1910, 21426, 1911; 6798, 1912.
1. Le Fibrocol, F. P. 349885, 1904, abst. J. S. C. I. 1905, **24**, 855. M. Bonnet, F. P. 365285, 1906; abst. J. S. C. I. 1906, **25**, 942. See also Papierfabr. M. A. 1903, 521; 1905, 1885; abst. Rep. Tech. J. Lit. 1903, 790, 855; Papier. Ztg. 1897, **2**, 3396, Chem. News, 1906, **94**, 127. v. Possanner, W. Papierfabr. 1908, **33**, 604, 1221, 1557, abst. C. A. 1908, **2**, 2300; Rep. Tech. J. Lit. 1908, 732.
2. W. Winter, D. R. P. 227208, 1909; abst. Kunst. 1911, **1**, 50; C. A. 1911, **5**, 2160; Zts. ang. Chem. 1910, **23**, 2446; Chem. Zentr. 1910, **11**, 1425. Wag. Jahr. 1910, **11**, 591.
3. J. Baylay, F. P. 477749, 1914; abst. C. A. 1916, **10**, 1595. J. Brandenberger, F. P. 447628, abst. Kunst. 1913, **3**, 95. W. Mymms, F. P. 25439, 1911. The plastic mass of viscose to serve principally for the manufacture of polishing and grinding wheels, is described in the patent of Livette & Findeisen, D. R. P. 190569, 1907; abst. Chem. Zentr. 1907, **78**, 11, 1880. M. Zelensky (E. P. 2156, 1906) prescribes hollow posts with a coating of viscose. D. Beatty and S. Irving (U. S. P. 883442, 1909) prepares a felt-like substance from magnesium cellulose.
4. R. Dittmar, Pharm. Zentralhalle, 1914, 888; abst. Kunst. 1914, **4**, 358. G. Pum and A. Glaessner, U. S. P. 1142619; abst. C. A. 1916, **8**, 1978. P. Roder and B. Raabe, Aust. P. 63556; abst. Kunst. 1914, **4**, 195. Aust. P. Ann. A 8607, 1913. Addn. to Aust. P. 63556; abst. Kunst. 1914, **4**, 200; C. A. 1914, **8**, 3354.
5. B. Honowsky, U. S. P. 925104, 1909.
6. U. S. P. 1217123, 1917.
7. U. S. P. 719787, 1903; abst. J. S. C. I. 1903, **22**, 308. E. P. 17253, 1900; abst. J. S. C. I. 1901, **20**, 597. F. P. 304143, 1900; abst. J. S. C. I. 1903, **22**, 1007; Mon. Sci. 1901, **15**, 224. D. R. P. Ann. A 4884, 1900; abst. J. Soc. Dyers and Col. 1900, **17**, 299; Oesterr. Wollen und Leinen Ind. See also G. Winterbottom and J. Egerton, E. P. 12687, 1909.

factory results. The products as devised by O.¹ Eberhard,¹ Chem. Fabrik. Heidenau,² G. Bonwit,³ H. Lieber,⁴ V. Ottorepetz,⁵ J. Morison,⁶ J. Taylor,⁷ E. Harrison,⁸ F. Meyer,⁹ and others,¹⁰

1. E. P.² 2149, 1912;³ 3042, 1912; abst. J. S. C. I. 1912, **31**, 638; C. A. 1913, **7**, 2487; Kunst. 1912, **2**, 355; F. P. 439332, 1912; abst. J. S. C. I. 1912, **31**, 680. D. R. P. 250753, 1911; abst. Kunst. 1913, **3**, 79, 137; C. A. 1913, **7**, 2472. D. R. P. Ann. E. 16653, 1911; abst. Kunst. 1914, **4**, 299.
2. E. P. 3042, 1912; abst. J. S. C. I. 1912, **31**, 636; F. P. 439332, 1912, abst. J. S. C. I. 1912, **31**, 680; Kunst. 1912, **2**, 316. Aust. P. Ann. 406, 1912. R. de Chazelles, D. R. P. 178644; abst. Wag. Jahr. 1907, II, 564; Zts. ang. Chem. 1907, **20**, 461; Chem. Centr. 1907, I, 916. Chem. Fabr. von Heyden, D. R. P. Ann. C. 22132, 1912, abst. Kunst. 1912, **2**, 420. Belg. P. 247552, 1912; 250077; abst. Kunst. 1913, **3**, 235. Belg. P. 251405; abst. Kunst. 1913, **3**, 235. Swiss P. 60741, 61081, 1912 (See also U. S. P. 896715, E. P. 2529, 1902. D. R. P. 187947) Swiss P. 62314, 1912; abst. Chem. Ztg. Rep. 1913, **37**, No. 140, 1442.
3. Zts. ang. Chem. 1913, **26**, 89; abst. J. S. C. I. 1913, **32**, 227; C. A. 1913, **7**, 1969; Mon. Sci. 1915, 89.
4. U. S. P. 1213115, abst. C. A. 1917, **11**, 881; J. S. C. I. 1917, **36**, 334.
5. E. P. 23196, 1913.
6. E. P. 22371, 1907, abst. J. S. C. I. 1908, **27**, 1110.
7. U. S. P. 1172073, 1916; abst. J. S. C. I. 1916, **35**, 429; C. A. 1916, **10**, 1104. See also E. P. 2167, 1915; abst. J. S. C. I. 1916, **35**, 429.
8. E. P. 13091, 1912; abst. J. S. C. I. 1913, **32**, 748; C. A. 1913, **7**, 4050.
9. E. P. 293963, 1908; abst. J. S. C. I. 1909, **28**, 257; C. A. 1907, **1**, 118. See also J. C. S. 1907, 89; 1908, 89. J. S. C. I. 1901, **20**, 741.
10. The Commercial Products Co., Ltd. Swiss P. 50079, 1909. Herzinger, Muster Ztg. 1905, **54**, 164; abst. Text. Col. 1905, **27**, 34. Chem. Fabr. von Heyden, D. R. P. 296405, 1916; abst. J. S. C. I. 1917, **36**, 503. L. Lesage, F. P. 382309, 1906; abst. J. S. C. I. 1908, **27**, 235; F. P. 385381, 1907, abst. J. S. C. I. 1908, **27**, 634. L. Lilienfeld, Aust. P. 47239, see also Aust. P. 47237, 47238. E. P. 26028, 1910; abst. J. S. C. I. 1912, **31**, 122. C. Shragar and R. Lance, E. P. 8283, 1913, abst. J. S. C. I. 1913, **32**, 785; F. P. 453652, 1912; abst. J. S. C. I. 1913, **32**, 785; F. P. 471471, 1913; abst. J. S. C. I. 1915, **34**, 418. Soc. France de la Viscose, D. R. P. 188823, 1906; abst. Wag. Jahr. 1907, II, 563; C. A. 1908, **2**, 734; Zts. ang. Chem. 1908, **21**, 211; Chem. Zentr. 1907, II, 1821; Jahr. Chem. 1905-08, 987; Chem. Tech. Rep. 1907, **31**, 504. Chem. Ind. 1907, **30**, 535; Mon. Sci. 1910, (4), **72**, 77. D. R. P. 188910; abst. Zts. ang. Chem. 1908, **21**, 971. W. Glover and L. Wilson (U. S. P. 1279328, 1279329, 1918) treat alkali cellulose with oxidizing agents as sodium peroxide in the formation of viscose plastics. H. Grandage, R. Farnworth and A. Fielding (E. P. 8795, 1903) make rollers for calendaring machines of viscose. The dentifrice of L. Slaughter (U. S. P. 1275779, 1918; Can. P. 190220, 1920; abst. J. S. C. I. 1918, **37**, 651-A) with a basis of finely divided, non-structural cellulose hydrate, is prepared by changing viscose into a gelatinous mass with sodium bisulfate. J. Young U. S. P. 1327933, 1920; abst. J. S. C. I. 1920, **39**, 227-A) mixes viscose with a soapy material, as an adhesive coating. The adhesive of G. Hildenbrandt (D. R. P. 311557, 1916; abst. J. S. C. I. 1919, **38**, 594-A) comprises sodium cellulosexanthate, starch and sulfite cellulose. The photographic printing paper and transfer process of Kerotype, Ltd. and T. Middleton (E. P. 29616, 1912; 22091, 1915; 126149; abst. 1914, **33**, 221; 1916, **35**, 1038; 1919, **38**, 541-A) employs viscose. The binder of "porolac" Holzmasse-Ges. (Aus. P. 60136) consists of viscose. The gas bags for hydrogen of C. Dreyfus (E. P. 126347, 1916; abst. J. S. C. I. 1919, **38**, 496-A) are sheets of non-fibrous cellulose as those prepared from viscose. In this connection compare, Sage, L'industrie textile, 1909, 234; abst. J. Dyers

are typical of endeavors in this field. L. Collard¹ has described a composite rubber product for ebonite composed of viscose and rubber. Other attempts to produce viscose-rubber plastics are found in the patented processes of C. Weber and A. Cairns,² H. Dogny and V. Henri,³ O. Welter and E. and B. Loewenthal,⁴ F. Smith,⁵ C. Posse,⁶ and especially those of P. Defaucamberg.⁷ For insulating, combinations of viscose with bituminous matter,⁸ lead oxides,⁹ glycerol,¹⁰ starch,¹¹ linseed oil,¹² and shredded wood¹³ have been patented. Many attempts have

¹ Col. 1900, **25**, 245. L. Vossen, Chem. Ztg. 1896, **20**, 385. Cines-Seta Artificielle, Ital. P. 128608. L. Pellegrini, Ital. P. 132219, 132220, 1913. J. Goepfer and O. Geiger, F. P. 434065, 1911, 450758. A. Fiedling fixes viscose on textiles (U. S. P. 708761, F. P. 320478, 1902, abstr. J. S. C. I. 1902, **21**, 1230; 1903, **22**, 25). H. Hiral (Jap. P. 20818, 35020, abstr. C. A. 1920, **14**, 2418) prepares viscid paper by digesting paper in a mixture of viscose 10, glycerol 0.3, potassium oleate 0.2 and water 100 parts. W. Bonner (U. S. P. 1180902, 1936) treats jointly oleic acid and cellulose, first with sodium hydroxide, then with carbon disulfide. C. Stulemeyer, D. R. P. Aqm. 32808, 32809, 1920; Chem. Ztg. 1920, **44**, 367. C. Meyer and Heck, D. R. P. Ann. M-50538, Chem. Zentr. 1917, **90**, 11, 79.

² U. S. P. 1098882; abstr. C. A. 1914, **8**, 2816. 1128851, abstr. C. A. 1915, **9**, 1135. E. P. 1598, 1912, abstr. C. A. 1913, **7**, 2486, Kunst. 1913, **3**, 205. J. S. C. I. 1913, **32**, 498. E. P. 1599, 1912, abstr. J. S. C. I. 1913, **32**, 198, C. A. 1913, **7**, 2486, Kunst. 1913, **3**, 205, F. P. 453396, 1913; abstr. J. S. C. I. 1913, **32**, 760, abstr. C. A. 1913, **7**, 4087, Swed. P. 40613, 1916, abstr. C. A. 1916, **10**, 2418. Belg. P. 252907, abstr. Kunst. 1913, **3**, 270. Swiss P. 63587, 63821, 1913, abstr. C. A. 1914, **8**, 2270, Kunst. 1914, **4**, 102. The proteid viscose combination of H. Chavassien (E. P. 26155, 1908, 18316, 1910. Can. P. 117604, 1909) is similar.

³ E. P. 50, 1901, D. R. P. 138511, 1901, abstr. Chem. Zentr. 1903, **1**, 373.

⁴ E. P. 26932, 1910, F. P. 420321, abstr. Kunst. 1911, **1**, 156.

⁵ F. P. 452482, 1912, abstr. J. S. C. I. 1913, **32**, 706, Kunst. 1913, **3**, 295.

⁶ E. P. 26695, 1896.

⁷ D. R. P. 262552, 1912, abstr. J. S. C. I. 1913, **32**, 824; Kunst. 1913, **3**, 474; C. A. 1913, **7**, 3646. D. R. P. Ann. P. 26136, 1912; abstr. Kunst. 1913, **3**, 318.

⁸ U. S. P. 943685, 1909, abstr. J. S. C. I. 1908, **27**, 100; E. P. 7302, 1909, abstr. J. S. C. I. 1909, **28**, 844, C. A. 1910, **4**, 108; F. P. 398628, 1908; abstr. J. S. C. I. 1909, **28**, 844; D. R. P. 228705, 1910; abstr. Kunst. 1911, **1**, 56; C. A. 1911, **5**, 2177; Zts. ang. Chem. 1910, **23**, 2446; Chem. Zentr. 1910, **11**, 1844. D. R. P. Ann. S. 28642, 1909. Belg. P. 214842, 1909. Aust. P. 43334, 1910. Aust. Ann. 2344, 1909. Swiss P. 47267, 1909. Ital. P. 305, 206, 102133, 1910. See also Hofmann's Prakt. Handbuch der Papierfabrikation, (44), 1703; abstr. J. S. C. I. 1897, **16**, 552.

⁹ C. Bradle, E. P. 22022, 1897, abstr. J. S. C. I. 1898, **17**, 930.

¹⁰ G. Hubner, D. R. P. 82111, 82112, 1894, abstr. Ber. 1895, 939.

¹¹ B. Sauton, F. P. 385019, 1907.

¹² A. Weber, D. R. P. 228888; abstr. C. A. 1902, **6**, 163; Zts. ang. Chem. 1911, **24**, 192, Waf. Jahr. 1909, **11**, 554; Kunst. 1911, **1**, 57.

¹³ J. Brandenberger, F. P. 433999, 1910.

¹⁴ S. Cabot, U. S. P. 991271, 1911; E. P. 30548, 1909; abstr. Kunst. 1913, **3**, 411.

been made to combine the proteids, as plasticizing agents in combination with viscose, glue,¹ casein,² fibrin,³ and other albuminoids⁴ having been described. Other technical applications of viscose is as paint material,⁵ fibrous caps for bottles,⁶ and casing for sausages.⁷

In the coating of thread with viscose in the formation of "artificial horse hair," and known commercially as "Viscelline yarn," thread is coated with viscose solution and the xanthate then "reverted." The processes of J. Christophe,⁸ L. Chorier,⁹ C. Waite¹⁰ and the Societe Francaise de la Viscose are for this:

1. L. Collardon, U. S. P. 93319, abst. F. P. 372584, 1906; abst. J. S. C. I. 1907, **26**, 539.
2. Societe Le Fibrocol, F. P. 349885, 1904; abst. J. S. C. I. 1905, **24**, 885.
3. U. S. P. 950435; E. P. 26155, 1908; (abst. J. S. C. I. 1909, **22**, 1152). E. P. 18315, 1910; Addn. to E. P. 26155, 1908, F. P. 395402, 1907; abst. Chem. Ztg. Rep. 1909, **33**, 195; F. P. 11354, Addn. to F. P. 395402. D. R. P. 238348, 1908; abst. C. A. 1912, **6**, 1672; Zts. ang. Chem. 1911, **24**, 2229; Chem. Centr. 1911, II, 1285; Wag. Jahr. 1911, II, 423; Kunst. 1911, **1**, 22, 436, 456. D. R. P. Ann. C. 17392, 1903. Swiss P. 47266, 1908; 46446, 1909.
4. L. Collardon, D. R. P. 174877, 1904; abst. C. A. 1907, **1**, 1198; D. R. P. 186388, 1903; 225134, Addn. to D. R. P. 186388, 1903; abst. Kunst. 1911, **1**, 17. F. P. 359073; abst. C. A. 1907, **1**, 1647. U. S. P. 830493, 1906; 1128851, 1915; E. P. 1598, 1912; J. S. C. I. 1913, **32**, 498; 1915, **34**, 349. E. P. 22525, 1905; J. S. C. I. 1906, **25**, 327.
5. E. Thomas, J. Bonavita and M. Olivier, U. S. P. 646044, 1900; E. P. 9577, 1899; Dan. P. 3258, 1900; D. R. P. 117461, 118554, 125416, 1900; Norw. P. 8958, 1899; Aust. P. 4918, 1901; Swed. P. 11657, 1899; Hung. P. Sept. 22, 1899. J. Brandenberger, E. P. 24809, 24811, 1908; J. S. C. I. 1909, **28**, 851; F. P. 405430; U. S. P. 891368, 1911; for paper size or paint from regenerated cellulose obtained from viscose. "Fibrol" or "peinture incombustible" is viscose mixed with zinc oxide, barium sulfate or other incombustible pigment. "Decapant" or "Clysol" is an alkaline viscose paint remover. The artificial straw from viscose by J. Brandenberger, is described in F. P. 436186, 436187, 436188; Mon. Sci. 1913, **77**, 181.
6. Flusin, Ann. Chim. Phys. 1908, (8), **13**, 480, abst. Chem. Centr. 1908, I, 1914. Viscose Development Co., and J. Moffat, E. P. 14194, 1910, see also E. P. 2880, 1905. D. R. P. 270314, 1911; abst. Kunst. 1914, **4**, 80, 116. D. R. P. Ann. V. 9896, 1911; abst. Kunst. 1912, **2**, 439. Hung. Ann. V. 1171, 1911. A. Westlake, E. P. 16148, 1915; abst. J. S. C. I. 1916, **35**, 961; see also U. S. P. 1160478, 1915; abst. J. S. C. I. 1915, **34**, 1244; E. P. 2604, 1867; 17883, 1899.
7. W. Cohoe, U. S. P. 1070776, 1913; 1158400; abst. C. A. 1915, **9**, 3358; J. S. C. I. 1915, **34**, 1222; E. P. 15776, 1914. W. Cohoe, E. Fox, and A. Acton, J. S. C. I. 1914, **33**, 947; abst. C. A. 1915, **9**, 227. W. Davies Company, E. P. 27966, 1912. D. Manivet, E. P. 19744, 1911.
8. U. S. P. 1184223, 1916; abst. C. A. 1916, **10**, 1790.
9. E. P. 912812, 1909; abst. C. A. 1909, **3**, 1092; J. S. C. I. 1909, **28**, 307; F. P. 335598, 1903; abst. J. S. C. I. 1904, **23**, 251. See also A. Wilson, E. P. 5170, 1913; abst. C. A. 1914, **8**, 2785; J. S. C. I. 1914, **33**, 477. Wolterbeck, E. P. 3898, 1898; abst. Wag. Jahr. 1898, 994.
10. U. S. P. 689336, 1901; 759332, 1904; 791335, 1905; abst. J. S. C. I. 1905, **24**, 727. 791336, 1905; abst. J. S. C. I. 1905, **24**, 727.

purpose.¹ A novel use² has been proposed in which alkali cellulose is used to remove the carbon disulfide from gases, the latter uniting with the alkali cellulose to form xanthate. W. Bonner prepares a substance resembling viscose³ by treating cellulose with ammonia and then reacting upon the substance thus formed with water.

Xanthates of the carbohydrates, especially of starch, have been investigated by C. Cross and J. Briggs,⁴ Cross, Bevan and Briggs,⁵ H. Ost, F. Westhoff and L. Gessner,⁶ while E. Stern and F. Sichel,⁷ E. Trutzer,⁸ and L. Kur⁹ have suggested commercial uses.

1. E. P. 24637, 1903, abst. J. S. C. I. 1904, **23**, 1087; Can. P. 95927, 1905. See also E. Debuchy, J. Pharm. Chim. 1901, **14**, (6), 151; abst. Chem. Centr. 1901, II, 788.

2. E. Knoevenagel, J. Reis, and F. Kuckuk, E. P. 3034, 1912. D. R. P. 250900, 1911, abst. C. A. 1913, **7**, 253; Zts. ang. Chem. 1912, **25**, 2335.

3. U. S. P. 1173336, 1916; abst. J. S. C. I. 1916, **35**, 465; C. A. 1916, **10**, 1269. U. S. P. 1180902, abst. C. A. 1916, **10**, 1690; J. S. C. I. 1916, **35**, 629.

4. E. P. 20638, 1906; abst. J. S. C. I. 1907, **36**, 1103; F. P. 370505, 1906; abst. J. S. C. I. 1907, **36**, 267; Mon. Sci. 1908, (4), **68**, 78.

5. J. C. S. 1907, **51**, 612; abst. Jahr. Chem. 1905-08, 948; J. Soc. Dyers Col. 1907, **23**, 190; J. S. C. I. 1907, **26**, 628 or 629; Chem. Centr. 1907, II, 2302; C. N. 1907, **95**, 178.

6. Ann. 1911, **332**, 340, abst. Kunst. 1912, **2**, 14; J. C. S. 1911, **55**, 1, 740; C. A. 1911, **5**, 3574. See also J. C. S. 1907, **51**, 612, abst. J. S. C. I. 1907, **26**, 628 or 9.

7. E. Stern and F. Sichel, E. P. 3338, 1915; abst. C. A. 1916, **10**, 2160.

8. D. R. P. 273481, 1913, abst. C. A. 1914, **8**, 2793. J. C. S. I. 1914, **33**, 750.

9. D. R. P. 217237, 1908.

ERRATA

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71-32	E. P. 25333	E. P. 25533
79-37	Traube	Taurke
86-30	Heyderhaus	Heydenhaus
89-11	P. P. 385053	F. P. 385083
89-12	Apr. 27, 1907	208472
184-10	Neuberf	Neuberg
187-37	Laszio	Laszlo
198-9	celluose	cellulose
202-3	W. Wilkening	L. Wilkening
209-38	1033064	1037185, 1032440-1.2-5-6-7-8
212-15	VII	XVIII
213-5	Boernen	Boerner
213-5	Bouchard	Bouchaud
225-31	Salis, Schwade and Co.	Salis, Schwabe and Co
227-8	Lavel	Laval
227-23	Dolber	Dolder
228-34	1900	1890
230-23	Gros & Boucart	F. Gros and P. Bourcart
232-2	cellouse	cellulose
234-27	B. Beresin	P. Beresin
238-27	Kiliana	Kiliani
236-12	trimellitica	trimellitic
248-24	combination	combination
260-30	11946	111946
275-12	1145	1154
275-46	1311211	1311221
279-35	Hoening	Koenig
285-21	2033	203-A
287-8	o ly	oily
288-21	E. Durnford	A. Durnford
288-34	A. Sparre	P. A. Sparre
291-47	Karr	Carr
292-26	D.	P
293-19	190	1900
299-1	Willstaetter	Willstaetter
300-8	J. Bevan	E. J. Bevan
303-34	Heden	Hedin
304-8	Willstatter	R. Willstatter
309-4	Segerfeld	Segerfelt
315-22	F. and W. Haage	E. Trauner and W. Haage
315-23	1365	1148
326-35	C. A. 1912	C. A. 1911
328-38	Verbrese	Verbiese
336-28	Coumbray	Coumbary
341-19	Penticost	Pentecost
342-31	Ammonia	Ammonium
360-9	thoroughyl	thoroughly
368-24	Benedict	Beuedik
392-6	Guerin-Vary	R. Guerin-Varry
413-24	Blondonneau	Bondoum
414-6	de Conick	de Coninck
415-11	Oechsner de Conick	Oechsner de Coninck
415-34	Struters	Struthers
424-9	propionicaldehyde	propionicaldehyde

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449-29	W. Rochteschel	W. Rockteschel
450-4	ofs tarch	of starch
458-7	Engster	Engster
472-3	was	wer
477-9	W. Oeschnerde	W. Oechsnerde
484-41	1318106/1919	1318106/1919
496-7	<i>barnadense</i>	<i>barbadensis</i>
501-12	destroyed	destroyed
532-37	Jones	Johns
562-20	Rohm	Rohn
572-32	8544	8544, 1901
600-40	degradation	degradation
612-14	Cadoret	Cadoret
657-20	Early	Early
671-20	Vibans	Vibrans
673-42	J. Hittorf	J. Hittorf
680-5	Kavlegh	Kavlegh
682-43	788	788 Meister, Lucius u. Brün ing, F. P. 453845, U. S. P. 1006302, 1006303, E. P. 28737, 1913.
693-16	E. P. 13989, 1906	Delete
696-29	B. Bunet	P. Bunet
695-9	Hofer	Hofer
695-28	Marqueyrol	Marqueyrol
696-42	A. and C.	C. and P.
704-17	Finckh	Finckh
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709-32	Parks	Parkes
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743-17	Bauschlichter	Bauschlichter
771-38	HNO ₂	HNO
797-5	Rothamsted	Rothamsted
805-28	Dior	Dior
808-32	E. P. Appl	E. P.
846-41	E. P.	F. P.
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882-37	F. P. 374237	F. P. 374237
895-9	Meneghini	Meneghini
895-9	A. Remders and A. Cats	W. Remders and A. Cats
923-21	Podazus	Podszus
931-3	C. Bredig	A. Bredig
937-36	Aktuebolaget	Aktuebolaget Nitrogenium
935-21	Powder	Power
936-33	Um	Ann
937-9	with	contam
937-12	interchanged	interchange
941-44	35	36
945-46	E. Permann	E. Herman
961-41	Libenstem	J. Libenstem
985-9	oxygen	nitrogen
987-33	Dieberle	Dieckle
986-20	R. Sohlman	R. Sohlman
990-46	P. Sohlman	R. Sohlman

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1006A-57	C. Coutagni	G. Coutagni
1011-3	H. Ranson	H. Rawson
1011-21	Moncton	Monckton
1012-15	Masini	Nasini
1012-53	Boguski	Boguski
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1015-52	Ilsovy	Ilsovay
1016-18	Spilka	Spilker
1050-37	Moulinie	Molinie
1056-16	Gaon	Garn
•1070-44	P. Piperaut	P. Pipereaut
•1072-50	S. Beuve	A. Saint-Beuve
1073-46	A. Merton	T. Merton
1087-23	Rumfmiller	Rumpfmiller
1092-44	L. Heintz	N. Heinz
1100-40	Dietz	Ditz
1122-32	J. Pintsch Akt. Ges.	J. Pintsch Akt. Ges.
1203-25	L. Heinz	N. Heinz
1208-41	Klenke	Klencke
1211-34	752377	752677
1218-68	911	1911
1270-12	A. Wülsche	A. Wünsche
1276-32	C. Beck	J. Beck
1280-3	Vereinigte Damfziegeleisen	Vereinigte Dampfziegeleien
1291-48	Quinn	Quinan
1299-35	Burburg	Burbury
1330-6	Geier	Gaier
1335-42	W. Steenberge	H. Steenbergen
1335-43	J. S. C. I. 1917, 36, 2860	C. A. 1917, 11, 2866
1352-9	N. Swinden	N. Swindin
1518-44	Kaesmacjer	Kaesmacher
•1571-28	A. Seguir	A. Segurier
1588-2	Dumonte	Domonte
1718-32	-SO ₄ N	-SO ₄ M
1785-37	Belg.	E.
1817-16	replacement	employment
1819-5	T. Hess	F. Hess
1826-16	C. Arnold	G. Arnold
1880-2	Omar	Oman
1883-40	R. Louis	R. Lewis
1887-32	Segurier	Seguir
1901-34	L. Duvivier	J. du Vivier
1924-33	Bouchard	Bouchard
1942-30, 31	England is shown in Figs. 145 and 146 and in France in Fig. 147.	France is shown in Fig. 145 and in England in Figs. 146 and 147.
1979-2	"gelatin"	Delete
1983-14	45 mins.	3 hours
1987-3	pots	pans
2002-4	N. Raltenbach	M. Raltenbach
2011-20	Voswinkel	Voswinkel
2026-8	E. Quinan	C. Quinan
2026-32	After note 3 insert A. Luck and	C. Cross
2075	Ardeer	Glasgow

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2067-5	Umpherson	Umpherston
2068-14	Fig. 220	Figs. 221 and 222
2068-36	also	Delete
2099	or tuns	Delete
2130-23	Fig. 240	Fig. 241
2162-30	Petry and Falkenstein	T. Petry and O. Falkenstein
2168-15	Figs. 255, 256	Figs. 265, 266
2168-17	257	263
2176-31	boiled	Delete
2178-36	after stoving (drying)	after stoving
2181	with	into
2181	after moulding and firing	after moulding into primer form
2313-49	M. Margueryrol	Marqueyrol
2334-40	A. Schmidt	J. Schmidt
2400-42	Chem. Ztg.	Chem. Zentr.
2400-45	E. Krugel	E. Krugel
2414-11	A. Trilat	A. Trillat
2440-16	Pawleski	Pawlewski
2454-3	C. Morin	E. Morin
2454-29	Bull. Soc. Chim. 1888, 43, 55	Bull. Soc. Chim. 1888, 43, 178
2487-12	C. Tischenko	G. Tischenko
2496-41	P. Pawlewski	R. Pawlewski
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2499-9	Elasser	Elsasser
2502-33	A. Krueck	C. Krügel
2504-4	K. Winkelbleck	K. Winkelblech
2506-27	W. Ramsey	W. Ramsay
2548-11	pyrocatechuic	protocatechuic
2552-39	C. Hosie	G. Hosie
2559-11	Establissemments Poulenc	Établissements Poulenc Freres
2562-2	H. von Eicken and	Martini & Hüneke
2574-42	Schanschiff	Schanschiff
2594-16	Pharmaceutisches Institute	Pharmaceutisches Institut
2598-14	V. Perelzovich and G. Rosenbuch	V. Perelzveich and G. Rosen- busch
2624-45	T. Schrens	T. Schreus
2636-5	E. Tetley	H. Tetley
2637-1	G. Pun	G. Pum
2637-15	Pentacost	Pentecost
2650-34	Kunstzijdefabriek	Kunstzijdefabriek
2652-47	Pfersdorf	Pfersdorf
2659-11	Bewerbl.	Gewerbl.
2659-49	G. Olmühle	O. Müller
2683-3	A. Mittelocher	A. Mittelacher
2693-3	T. Schrens	T. Schreus
2708-1	Tondio & Co.	Tondi & Co.
2740-1	G. Rutterfor & Son	G. Rutterford & Son
2750-9	Mittelacker	A. Mittelacher
2755-7	E. Peyrussen	J. Peyrussan
2758-3	Rasenack	F. Rasenack
2762-7	A. Pryn	A. Pryn
2787-53	E. Plescy	M. Plescy
2787-54	J. Schlumberger	I. Schlumberger
2789-31	C. Mitchell	C. Mitchell
2988-1	Erwig	Erwig

